Essays on Financial Stability: Lessons for Macroprudential Supervision and Regulation

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Abstract

Banking regulation and, in particular, macroprudential regulation have gained significant interest since the crisis that began in 2007. At the centre of banking regulation is a deep-rooted concern that the economic and social costs of systemic crises are significant and their implications are far-reaching. Banks play a number of crucial roles in the functioning of any economy. However, the banking system in which they operate is inherently fragile, and after many painful experiences, regulators are quite convinced that this is particularly true during economic downturns. As such, it is important to explore and assess prudential policies that could be designed or improved to prevent banking crises from occurring and to make the system more resilient.

This thesis uses panel micro-econometric methods to explore factors that could have an impact on financial stability and suggests policies that could be used to address them. The first essay empirically analyses how the capital buffer held by banks behave over the business cycle after financial factors have been accounted for. Using a large panel of banks for the period 2000-2014, it documents evidence that capital buffers behave more pro-cyclical than previously found in the literature. Furthermore, it also shows that this relationship is more pronounced for large commercial banks where access to bail-out and equity markets incentivise an increase in credit exposure and reduced capital reserves accordingly.

The second essay notes that a common feature within a lot of corporate income

tax systems is the long-standing bias towards debt finance. That is, the cost of debt has been deductible as an expenditure when calculating taxable profits. An unintended consequence of this tax distortion is the creation of under-capitalized firms - raising default risk in the process. Using a difference-in-differences technique, this essay demonstrates that with a more equal treatment of equity and debt, banks capitalisation significantly improves. The essay takes advantage of the exogenous variation in the fiscal treatment of equity and debt as a result of the introduction of an Allowance for Corporate Equity (ACE) system in Italy, to identify whether an ACE positively impacts banks' capital structure. The results demonstrate that a move to an unbiased corporate tax environment leads to better capitalised banks, fuelled by equity growth rather than a reduction in lending activities. The change also triggers a decrease in the risk-taking of ex-ante low capitalised banks.

The third essay analyses the impact of liquid asset holdings on bank profitability. Using a large sample of banks, the essay documents evidence of a non-linear relationship between additional liquid asset holdings and bank profitability. That is, banks' profitability is improved with the holding of some liquid assets. However, evidence suggests that there is a point at which holding further liquid assets diminishes profitability. The essay also finds that growth in credit and asset prices is more important for bank profitability than output growth, suggesting that bank returns respond to the financial and not the business cycle. Another important finding of this essay is that long-term interest rates tend to increase bank profitability, whilst short-term rates tend to lower bank profits - via increasing funding costs. These findings are homogeneous across countries with different development status as these results appear consistent for advanced and emerging market economies.

Overall, the findings from this thesis provide important implications for regulators seeking to provide stability and resilience to the financial system. They provide further evidence that supports the call for the use of countercyclical capital buffers, but more importantly, they highlight the need for a more rigid approach to the setting of the countercyclical capital buffer rate. The thesis also suggests that an allowance for corporate equity system that eliminates or significantly reduces the tax-induced distortions in banks, might be worth considering as a macroprudential policy tool that targets capital standard. Finally, it also highlights the importance of finding the right balance between policies geared toward mitigating liquidity risk and maintaining bank profitability.

Declaration

I certify that the thesis I have submitted for examination for the award of a Ph.D. degree by the University of Sheffield is solely my own work, other than where I have clearly indicated otherwise (in which case the extent of any work produced jointly by myself and any other person is clearly identified in it).

I warrant that this authorisation does not, to the best of my knowledge, infringe the rights of any third party.

I certify that this thesis consists of approximately 45,000 words.

Acknowledgement

Because this may be the only opportunity I get to thank these individuals in writing, I may be a bit more verbose in my acknowledgements than necessary. Regrettably, but inevitably, the names mentioned will be incomplete, but I hope that those who are missing will forgive me, and still accept my sincere appreciation of their influence on my work.

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Chapter 1

Introduction

1.1 Motivation and Objectives

The pervasive nature of banking crises amplifies the need to continuously monitor and regulate the banking sector. These crises are important not only due to the direct impact they have on the banking sector, but also due to the fact that they typically affect the entire economy. As the quintessential example, the global financial crisis which began in 2007 negatively impacted the financial systems of most developed economies and seriously threatened those of emerging economies. This severe crisis not only caused a collapse in the financial sector, but its lag effect permeated through to the real sector of the economy, causing a "Great Recession". This crisis originated in the United States, but quickly spread to most of the global economy.

During these periods of financial stress, the typical credit channel via monetary policy may not be as effective in stimulating credit growth since banks are likely to be burdened by non-performing loans that deplete their capital buffers. This means, banks may be reluctant to increase lending in response to monetary accommodation because this will further decrease their capital ratios, putting them at risk of falling below the regulatory minimum and facing subsequent supervisory fines. By contrasts, macroprudential policy, and in this specific case, the countercyclical capital buffer would have built up capital buffers during booms that could then be released in stress periods, thereby easing the strains on credit supply.

Macroprudential regulation is meant to protect the banking system from these problems, or at least to limit their frequency and impact. There have been ongoing calls in recent times for financial regulators and supervisory authorities to strengthen their macroprudential framework. As Hellmann et al. (2000) highlight, the term macroprudential has become so widely accepted that, just as Milton Friedman claimed, "we are all macroprudentialists now". However, not long ago, the term was hardly ever mentioned. In fact, it would have been difficult for regulators to recognise that their duties involved a significant macroprudential dimension, let alone a need to strengthen it (Hellmann et al., 2000).

In fact, the term is not new. It has been broadly defined in an early Bank for International Settlements (BIS) paper as a policy that seeks to promote financial system soundness. It denotes a systemic or system-wide orientation of regulatory frameworks and the link to the macroeconomy. The term or the concept of macroprudential regulation has become more commonplace since the financial crisis of 2008. As Baker (2013) points out, it went from being largely unpopular and unused, to being at the forefront of the policy agenda and came to represent a new Basel consensus. It became the principal interpretative tool for financial regulators attempting to diagnose and understand the financial crisis and to advance institutional blueprints for regulatory reform.

Traditionally, prudential regulation consisted of a mixture of monitoring individual transactions, capital requirements, and entry requirements. Concerns regarding bank runs have also forced a number of countries to provide deposit insurance and to establish a central bank to act as a lender of last resort. However, in recent times, several changes have been made in the system of prudential regulation. Amongst these changes, two in particular have taken great importance. First, there has been greater emphasis on monitoring banks' risk management systems, and less emphasis on monitoring individual transactions. Second, there has been greater emphasis on capital requirements, typically using the BIS standards of the Basel Accord.

In what follows, I develop some reflections on a theme in supervision and regulation that has come to prominence in the wake of the recent global financial crisis. The three essays in this thesis aim to identify developments in the financial sector that have the potential to affect the economy as a whole, and suggest macroprudential policy tools that can be used to circumvent these problems. The first essay is motivated by the fact that the typical credit channel via monetary policy becomes inefficient, particularly during periods of stress or crises. As such, it creates a role for the use of macroprudential policy tools to stabilise the economy. In addition, it is motivated by the fact that, in assessing the cyclical behaviour of banks' capital ratio, the literature tends to ignore the role of the financial cycle or financial sector activities. This essay addresses the issue of the pro-cyclicality of banks' capital buffer. While this particular topic is not new, as it has been previously analysed in the financial stability literature, the studies fail to account for the role of the financial cycle in observing the cyclical behaviour of capital.

Therefore, the first essay seeks to re-examine the following questions:

- Are banks' capital buffers pro-cyclical?
- Do financial variables exacerbate the cyclical behaviour of capital buffers?
- Is there heterogeneity among banks in holding capital buffer?

The answers to these research questions have important implications for the design and development of macroprudential policy tools for the global financial system.[1]

The second essay is motivated by the introduction of an Allowance for Corporate Equity in Italy. The ACE is a reform of the corporate income tax system that sections of the financial stability literature have suggested could be a potential tool to complement the current macroprudential framework aimed at addressing issues concerning the treatment of bank capital (see for e.g. Schepens (2016)). The recent global financial crisis demonstrated that bank capital structure is one of the most important determinants of financial stability, as better capitalised banks tend to be more resilient to economic and financial shocks. Accordingly, it becomes important

[1] A previous version of this first essay has been revised and resubmitted to the *Journal of International Money and Finance* (JIMF).

to understand the determinants of bank capital structure. Most of the literature on capital structure mainly explores the bank-specific determinants. Consequently, the question of whether corporate taxes are important in explaining changes in bank capital structure is largely unexplored.

Because tax changes usually forms part of an overall tax reform, it is usually difficult to disentangle and isolate the exact effect of a tax shield. However, the exogenous change in the corporate tax laws in Italy allows for testing such an impact. Thus, the second essay exploits exogenous variations in the tax treatment of equity and leverage due to the implementation of an ACE in Italy, to identify whether it positively impacts banks' capital structure. The second essay therefore attempts to answer the following questions:

- Does the introduction of a tax shield for equity increase bank equity ratios?
- Does the allowance for corporate equity cause banks to reduce their level of riskiness?

The output of this essay will shed some light on the robustness of the ACE as a potential macroprudential policy tool.

The third essay of this thesis is motivated by the call of the Basel Committee on Banking Supervision (BCBS) to strengthen its liquidity framework, an action that has been strengthen since the recent global financial crisis. Recent studies have shown that during the crisis, banks that were more exposed to liquidity risk contracted their supply of credit more sharply (see for e.g. Ivashina and Scharfstein (2010) and Cornett et al. (2011)). This prompted various regulatory authorities to implement a standard that consistently and continuously monitors and improves banks' liquidity position. Consequently, it was recommended by G20 that the BCBS develop a global framework for promoting stronger liquidity buffers.

Meanwhile, actions taken by banks to address this issue and remain liquid - for example, 'fire sales' or overpaying for additional funds, can lead to a reduction in profits or even cause losses which undermine their capital position. Further, while holding a buffer of liquid assets will help to mitigate liquidity risks, they are also low yielding and as such have a significant opportunity cost. Therefore, it becomes important to ascertain what the impact is of a change in banks' liquid asset holdings on their profitability. Using a robust empirical approach, the third essay addresses the following issues:

- Is the relationship between liquid asset holdings and bank profitability non-linear?
- What is the role of the business cycle in explaining bank profits?
- Does the financial cycle predict bank profitability better than the business cycle?
- Is the reaction by banks homogeneous across countries with different development status?

The answer to these questions may have implications for the implementation of regulatory policies aimed at mitigating liquidity risks and the calibration of policy tools to account for the associated costs at the bank level. Answers to the last two questions in particular could inform counter-cyclical policies aimed at limiting the rapid deterioration of bank profitability during a downturn.

1.2 Thesis Overview

The structure of the thesis is as follows. Chapter 2 presents the first empirical essay which assesses the cyclical behaviour of bank capital buffer in a finance-augmented macroeconomy. Chapter 3 presents the second empirical essay. This essay examines the impact of an allowance for corporate equity on banks' capital structure. The final empirical essay is presented in chapter 4. This essay examines the impact of liquidity holdings on bank profitability and also assesses the role of the business and financial cycles in explaining changes in bank profits. Chapter 5 concludes the thesis by providing a summary of the main findings from all three essays. It also provides key policy implications, and proposes scope for future research.

The remainder of this section provides a brief overview of each essay in the thesis.

1.2.1 Chapter 2 Overview

The aim of this chapter is to empirically analyse how the capital buffer held by banks behaves over the business cycle after financial factors have been accounted for. Studies have shown that the Basel Accord on capital requirements is not sufficient to prevent an amplification in business cycle fluctuations, especially the decrease in banks' lending activity during a downturn in the cycle (e.g. Repullo and Suarez (2013) and Behn et al. (2016)). The chapter attempts to introduce a novel approach to capturing the business cycle by incorporating financial sector variables in its approximation. Drawing on recommendations from the empirical literature, the study considers, along with GDP, three additional financial variables to construct what is termed a "finance-augmented cycle". Specifically, it uses; residential property prices, credit-to-GDP ratio, and credit to the private, non-financial sector. The filter-based approach proposed by Hamilton (2017) is used to estimate the cycles.

The study utilises bank-level data retrieved from the Bankscope Database.[2] A generalised method of moments (GMM) technique is then used to test the pro-cyclicality hypothesis. That is, it first tests whether banks' capital buffers respond to the traditional business cycle in a pro-cyclical manner. It then tests whether this potential pro-cyclical behaviour is amplified by the introduction of the financial cycle. The results suggest, on average, banks' capital buffers are negatively related to the business cycle, which implies pro-cyclicality of the capital buffer. More importantly, the study finds that the capital buffer is even more sensitive to the cycle when financial variables are incorporated in the cyclical measure. In addition to the main findings, the study also observes that banks of different size (as measured by total assets) behave in a different manner. That is, only larger banks display this negative relationship - a concept that is consistent with the "too big to fail" hypothesis.

This chapter is unique in two ways. First, it differs from much of the empirical literature on banks' capital buffers, as most of these studies focus on a single country. This study is cross-country and provides results for countries across all three income levels. Second and more importantly, the majority of this literature solely focuses on the business cycle, disregarding the potential impact of financial sector activities. This analysis uses a proxy for the business cycle which accounts for developments in the financial sector. The inclusion of information about the financial side of the economy can provide more reliable estimates of the output-gap than the conventional filter-based approach used in the literature.

The results provide some important policy implications. From a macroprudential policy standpoint, regulators might want to adopt more flexible instruments to mitigate credit risk in banks globally. This recommendation is motivated by the fact

[2] The name of the database has since been changed to Orbis Bank Focus by the host, Bureau Van Dijk.

that even with the prudential framework set out in the new Basel accords (Basel III), the pro-cyclical behaviour of banks' capital buffers still persists. The analysis in this chapter demonstrates that it is not always safe to assume that regulatory or supervisory capital standards automatically constrain banks. The findings of this chapter also suggest that the approach to setting the countercyclical capital buffer rate might need to be a bit more rigid.

1.2.2 Chapter 3 Overview

Similar to Chapter 2, Chapter 3 seeks to address the capital structure decision of banks. Specifically, it aims to identify whether the introduction of a tax shield for equity leads to an increase in the equity ratio of banks. It also attempts to identify whether this allowance for corporate equity will cause banks to reduce their level of risk taking. The recent global financial crisis demonstrated that bank capital structure is one of the most important determinants of financial stability, as better capitalized banks tend to be more resilient to economic and financial shocks. At the same time, a common feature within the corporate tax environment is the tendency to have deductibility on the cost of debt as an expenditure in the calculation of taxable profits. An unintended consequence of this tax distortion is the creation of under-capitalized firms - raising default risk in the process.

As such, this chapter makes a comparison between the change in capital structure of Italian banks with that of a comparable group of European banks that did not experience a similar change in their tax environment. The introduction of an allowance for corporate equity in Italy provides an ideal scenario to carry out this experiment.

This chapter also uses bank-level data from Bureau Van Dijk's Bankscope Database. A difference-in-differences (DiD) method is used to check how this tax reform influences the capital structure of banks. The results suggest that treated banks, in this case Italian banks, significantly increase their capital ratios following the reform. The experiment further demonstrates that both high and low capitalised banks increase their equity ratios following the implementation of the tax shield. Another important finding coming out of this experiment is that the observed increase in equity ratios is driven by an increase in common equity rather than a reduction in assets. Finally, regarding the risk-taking behaviour of banks, the experiment shows that only under capitalised banks reduce their level of riskiness in response to the tax reform.

This paper therefore builds on two broad strands of the literature. First, it adds to the literature discussing the determinants of banks' capital structure, and capital structure decision. More importantly, it contributes to the relatively new literature surrounding the introduction of a tax shield for equity, to reduce the relative tax advantage of debt. The nature of Italy's banking system and the timing of the introduction of the ACE makes the findings of this study even more relevant for policymakers.

The key policy implication coming out of this chapter is the recognition that an ACE system that eliminates or significantly reduces the tax-induced distortions in banks, might be worth considering as a macroprudential policy tool that targets capital standard.

1.2.3 Chapter 4 Overview

This chapter of the empirical thesis explores the relationship between liquidity holdings and bank profitability. In the aftermath of the global financial crisis, there was a growing concern that liquidity risk management and the implications of such risk for individual banks, and also the banking system as whole, should take more importance. It led to widespread calls to strengthen the BCBS liquidity framework. However, highly liquid assets such as cash and government securities tend to have relatively low return, hence holding them imposes an opportunity cost on banks. It is therefore reasonable to expect that banks will only hold these assets to the extent where they contribute to maximizing profits. Beyond this, regulators may still require banks to hold further liquid assets if it improves the banking system's ability to withstand shocks arising from economic and financial stress. Against this background, the main aim of this chapter is to test empirically whether banks' holding of liquid assets significantly affect their profits. The chapter will also try to understand whether the financial or the business cycle better predicts bank profitability.

The data source for the bank-level data used in this chapter is the SNL Financial Database, which is maintained by S&P Global. The chapter also relies on macroeconomic data retrieved from the OECD Databank. The GMM estimator is used to explore the impact of liquidity on bank profitability. The results emerging from the empirical analysis suggest that there is a non-linear relationship between liquidity and bank profitability. That is, profitability increases for banks that maintain some liquid assets, however, at some point holding more liquid assets starts to negatively affect profitability. The other important finding emerging from the analysis is that profitability responds to measures of the financial cycle, while there is no evidence to suggest that the business cycle predicts profitability.

This chapter makes two important contributions to the literature. First, while a limited number of papers control for liquidity when estimating bank profits, this specific relationship is hardly ever the main focus of the paper. However, given the BCBS move to develop new standards aimed at reducing liquidity risk, it becomes important to study whether banks' liquid asset holdings significantly impact their level of profits. Second, it contributes to the literature surrounding the cyclical behaviour of bank profitability by exploring the role of the financial cycle, a phenomenon that has been largely ignored.

Some important policy implications emerge from this chapter. First, it might provide valuable information to regulators who continuously attempt to address liquidity risk. It provides information suggesting that these regulators might need to find the right balance between mitigating liquidity risk and maintaining profitability. Another implication coming out of this chapter concerns the macroeconomic cycle. For regulators and macroprudential policymakers, it might be more useful to use countercyclical policies that are geared toward smoothing credit cycles than those aimed at smoothing the business cycle, when considering bank profitability.

Chapter 2

Assessing the Cyclical Behaviour of Bank Capital Buffers in a Finance-Augmented Macro-Economy

2.1 Introduction

Following the recent financial crisis, bank capital requirements have become one of the key instruments of modern day banking regulation, providing both a cushion during adverse economic conditions and a mechanism for preventing excessive risk taking ex ante. Nonetheless, studies have shown that the Basel Accords (Basel I and Basel II) on capital requirements are not sufficient to prevent the pro-cyclical behaviour of capital buffers especially the decrease in banks' lending activity during the bust phase of the cycle (see for example; Gordy and Howells (2006), Repullo and Suarez (2013), and Behn et al. (2016)). This study considers as pro-cyclical (countercyclical) a bank capital ratio that is negatively (positively) correlated with the cycle. This means, other things being equal, the ratio tends to decrease (increase) when the economy or financial asset valuation is growing.[1] The financial turmoil of 2008 has forced the Basel Committee on Banking Supervision to update the regulatory requirements in order to mitigate risks and practices that would exacerbate this cyclical behaviour. To this end, one of the main objectives of the new regulations (Basel III) is to target pro-cyclicality through the building up of buffers in boom phases to be drawn down in bad times.

The main motivation behind the Basel III regulatory framework was influenced by the realisation that even banks with a good level of capitalisation suffer from systemic risk. This strengthened the call for a macroprudential dimension to augment firm level supervision and more stringent regulation of the banking system. The countercyclical capital buffer (CCCB) of Basel III would seek to build up buffers during booms that could then be used by banks during periods of stress. By increasing the capital buffer when risks are perceived to be low, banks will have an

[1]Capital buffer is the difference between the observed capital ratio in bank i in period t and the Basel Accord minimum regulatory capital. Pro-cyclicality in the financial system refers to the mutually reinforcing interactions between the real and financial sectors of the economy that tend to amplify business cycle fluctuations and that are often the cause of financial instability.

additional cushion of capital with which to absorb potential losses, enhancing their resilience and helping to ensure the stable provision of financial intermediation services. When credit conditions become weak and banks' capital buffers are judged to be more than sufficient, the buffer can then be drawn down. This will help to mitigate a contraction in the supply of credit to households and businesses.

This study shows that when the estimation of business cycles accounts for movements of financial variables, banks' capital ratios tend to behave more pro-cyclical than previously thought. The topic of pro-cyclical effects of bank behaviour as a consequence of capital requirements is not new and has also been previously analysed in the financial stability literature.[2] However, these studies neglect the role of the financial cycle when observing the cyclical behaviour of capital. There are two main reasons for this - the first is that for most of the post war period, the financial cycle was considered to be relatively unimportant in mainstream macroeconomics. The second reason is that there is no real consensus about the actual definition of the financial cycle, hence its subsequent measurement and approximation becomes difficult. Regarding the first reason, the view on the business cycle in traditional macroeconomics, which dates back to Okun (1963), define deviations from potential output with reference to developments in inflation. The assertion is, ceteris paribus, inflation falls when output is below potential and vice versa. This conceptual association grew so strong that it was hardly challenged in any regard. As a result, the role of financial factors have been largely ignored. However, the relationship between output and inflation has weakened over recent decades, thereby compromising the usefulness of inflation as a sole indicator of potential output. Accordingly, estimates of the output gap that rely on this relationship (the Phillips curve) may prove to be unreliable and inaccurate. In recent times, there has been evidence of inflation

[2]See for example: Jokipii and Milne (2008); Coffinet et al. (2012); Brei and Gambacorta (2016); and García-Suaza et al. (2012).

being low and stable yet output grow on an unsustainable path due to a build up of financial imbalances. This was quite evident during the global financial crisis of 2008.

The experience of the global crisis suggests that financial sector activities should be taken into account when estimating the level of potential output. In fact, the crisis came as a reminder that the real and financial sectors of the economy are inextricably linked. It is from this standpoint that Borio et al. (2016) argue, "if the ebb and flow of the financial cycle are associated with economic booms and busts, then surely assessments about the sustainability of a given economic trajectory should take financial developments into account."[3] This prompted new research in trying to incorporate financial factors in any assessment of potential output. Borio et al. (2016) estimate what they refer to as a "finance-neutral" cycle, which is a measure of the business cycle that takes into account private sector credit and property prices.

Against this background, this study examines the cyclical behaviour of banks' capital buffer over both the traditional business cycle and what this essay will refer to as a "finance-augmented business cycle". This study contributes to the literature by providing novel estimates on the relationship between banks' capital buffer and the finance-augmented output gap. As previously mentioned, most, if not all of the empirical studies undertaken in this literature, ignore the role of financial sector activities. In addition, a large share of this literature tends to focus on the determinants of bank capitalisation within a single country (see e.g. Shim (2013), Coffinet et al. (2012), Tabak et al. (2011), and Stolz and Wedow (2011)). This paper uses a sample of 33 low, middle, and high income countries to conduct the analysis. However, estimations using the finance-augmented output gap are carried out with a reduced sample of G7 countries, due to data availability.

[3] Borio et al. (2016) further argue it is simply impossible to understand business fluctuations and their policy challenges without understanding the financial cycle.

The results suggest, on average, banks' capital buffers are negatively related to the business cycle, hence suggesting pro-cyclicality of capital buffer. More importantly, it finds that the capital buffer is even more sensitive to the cycle when it incorporates financial variables (residential property prices, credit to the private, non-financial sector, and credit-to-GDP ratio) in the cyclical indicator. The magnitude of the coefficient on the finance-augmented cycle is markedly greater than that of the business cycle, suggesting some propagation of shocks to the real economy caused by financial sector activities. This result is consistent with the implication of the financial accelerator model where endogenous developments in credit markets can exacerbate and propel shocks to the real economy. In addition to the main findings, the study observes that the behaviour of capital buffers across banks is heterogeneous. That is, the negative relationship with the cycles is particularly pronounced for larger banks, consistent with the "*too big to fail*" hypothesis. Due to the perception that the creditors of large banks will be bailed out in case of bank distress, the cost of debt for large banks is lower. This makes larger banks more willing to use leverage and unstable funding, and to engage in risky market-based activities. Finally, the study finds that only savings and commercial banks display this negative relationship, with the latter being the main driver behind the pro-cyclical impact.

The remainder of the essay is organised as follows. Section 2.2 gives an extensive overview of the literature and the hypotheses. It also discusses the theoretical underpinnings of our empirical framework. Section 2.3 describes the statistical methodology used to estimate the cycles. Section 2.4 describes the dataset. Section 2.5 presents the econometric methodology to estimate the capital buffer. The empirical results are presented in section 2.6. Section 2.7 concludes.

2.2 Literature Overview and Theoretical Underpinnings

This section aims to clarify issues concerning the theoretical underpinnings of the empirical framework. In particular, it focuses on explaining the concept of pro-cyclicality, why banks hold excess capital, known as a capital buffer, and what are the determinants of capital buffers.

The recent financial crisis has brought to the forefront of banking regulation discussion the potential pro-cyclical effects of risk sensitive regulation. One of the primary aims of the Basel II accord was to link capital requirement to risks. However, estimates of risks tend to be higher in recession than in expansions. Therefore, under the Basel II accord, capital requirements are expected to increase during a recession, when building reserves becomes difficult while raising new capital is likely to be expensive. In this set up, banks would have to squeeze lending, which in turn would exacerbate a recession. This vicious cycle ultimately would undermine both the stability of banking and the macroeconomic system. As a result of this link between capital requirements, risk and business cycle, a widespread concern about Basel II is that it might amplify business cycle fluctuations, forcing banks to reduce credit when the economy enters into a recession. At the same time, there is a major concern that low capital requirements during upturns will generate credit expansion above a sustainable path which in turn will lead to asset price bubbles sewing the seeds for the next financial crisis.[4]

Although the Basel II accord has mainly focused on quantifying the likely variation of capital requirement implied by pillar 1, well functioning banks hold capital well above the minimum requirement on loan portfolios.[5] This suggests greater im-

[4] This is why capital requirements are said to be pro-cyclical despite actually increasing (decreasing) during a downturn (upturn).

[5] Note that under pillar 2 regulators are allowed to demand a buffer of additional capital during

portance of managing capital buffer across the business cycle than the management of capital requirement implied by pillar 1. In 2010, the Basel Committee on Banking Supervision introduced the new Basel III capital requirements. The introduction of this new framework was driven by the need to address the issue of pro-cyclicality. In this study, pro-cyclicality is considered as the negative interaction between business cycle and the capital buffer, which tend to amplify the former. Along similar lines, Ayuso et al. (2004), Jokipii and Milne (2008) and Jokipii and Milne (2011) associate pro-cyclicality with the negative correlation between capital buffer and economic activity. On the other hand, Brei and Gambacorta (2016) and Adrian and Shin (2010) define pro-cyclicality as the positive interaction between the leverage ratio and business cycle.

There is an extensive body of literature that investigates what is viewed as the pro-cyclical impact of the Basel II accord. For example, Repullo and Suarez (2013) investigate the pro-cyclical effects of bank capital regulation. They find that under cyclically-varying risk-based capital requirements, banks hold more buffers in expansions than in recessions. Nonetheless, these buffers are insufficient to prevent a significant contraction in the supply of credit when there is a recession. Their empirical results show that with cyclical adjustments to the Basel II requirements, this pro-cyclical effect on the supply of credit can be reduced without compromising banks' future solvency targets. The macroprudential framework of this newly implemented accord targets the building up of buffers during booms which could, in turn, be released during periods of stress.

Other papers that attempt to address the issue of pro-cyclicality have done so by highlighting the inverse relationship with the economic cycle. Coffinet et al. (2012) assess the extent to which capital buffers exacerbate rather than temper the cyclical behaviour of credit for French banks. Using both panel data econometric

economic expansion.

estimations and Granger causality tests, they find that both capital buffers and credit growth of French banks, depend on the output gap in a pro-cyclical manner. That is, the capital buffers intensify the cyclical credit fluctuations arising from output gap developments. The bi-directional causality that was identified between the buffer capital and loan growth further emphasizes the call for a countercyclical policy framework. Similarly, Tabak et al. (2011) provide evidence of pro-cyclicality among banks in Brazil. Their analysis of the relationship between the economic cycle and capital buffers held by banks reveal that capital buffer is negatively associated with the business cycle. It further demonstrates that these buffers tend to negatively impact loan growth. This is against the background that lending becomes particularly risky during stress periods.

Jokipii and Milne (2008) document a negative relationship between the capital buffer and the cycle. However, this largely depends on the size of the bank in question. Using a large sample of European countries over the the period 1997-2004, they find that bigger banks tend to hold less capital buffer and exhibit an inverse association with the business cycle. The opposite holds true for smaller banks, their capital buffer rises with the economic cycle. This finding for smaller banks is attributed to their ability to quickly react to periods of booms by increasing their loans, consequently their reserves increase since loan assets rise at a slower pace than for larger banks.

The differing behaviour of big and small banks is further explored by García-Suaza et al. (2012). They find that the capital buffers of small banks tend to vary over time, while those of big banks display a strong countercyclical behaviour. They explain that these banks behave differently due to the different access they have to equity markets. While larger banks can take advantage of the better access to capital markets, and as such reduce their capital buffers during booms, small banks find it more costly to restore their capital stocks, with their limited access to equity markets.

Using data on U.S. bank holding companies over the period 1992:Q1 to 2011:Q3, Shim (2013) demonstrates how banks actually adjust their capital buffers and risk over the business cycle. Consistent with other findings, he finds a negative relationship between the business cycle and capital buffers, indicating that banks tend to increase capital buffers by reducing their risk-weighted assets during cyclical downturns. Deriantino (2011) empirically demonstrates that there exists strong evidence of pro-cyclicality in capital buffers among banks in ASEAN countries. Specifically, the results suggest that loan growth is reduced when there is a contraction of the economy because of restrictions on lending influenced by the need to hold more capital buffers in order to mitigate credit riskiness.

2.2.1 Why do banks hold excess capital?

There are three main reasons why banks hold capital buffers. First, holding capital reduces the probability of default, which involves the loss of charter values, reputation costs, and legal cost of bankruptcy (see e.g. Acharya (1996)).[6] Second, and related to the literature on real investment, the changing of capital levels involves adjustment costs. Specifically, aside from pure transaction costs, the main adjustment costs are those associated with informational asymmetries in capital markets. With issuers holding an informational advantage over potential buyers, the resulting signals in the market would increase the cost of the desired adjustment (see, for example, Myers and Majluf (1984) or McNally (1999)). Third, Milne and Whalley (2001) highlight that though equity capital is expensive relative to debt, the poten-

[6] Lindquist (2004) argues that poorly capitalised banks are at a risk of losing market confidence and damaging their reputation. Similarly Estrella (2004) claims that excess capital acts as an insurance against costs that may occur due to unexpected loan losses and difficulties in raising new capital.

tial costs of a breach of the capital requirement is more detrimental. Coffinet et al. (2012) refer to these as "precautionary" reserves that serve to avoid adjustment costs that are associated with raising equity on short notice or supervisory penalties if they approach the regulatory minimum. They also argue that if regulatory capital is only an imperfect reflection of the risk of losing charter value, then capital buffers act as a cushion that protects its going concern value.

Note that designing the optimal level of capital buffer is not an easy task. Nonetheless, the theoretical literature is scant. Kashyap et al. (2004) suggest a simple conceptual framework that takes into account the trade-off between the cost and benefit of bank capital regulation. In particular, they argue that if the shadow value of bank capital is low in recession and high in expansion, then optimal capital charges should account for the state of the business cycle. One of the issues that have not been addressed by Kashyap et al. (2004) was whether in the presence of risk-sensitive capital regulation banks have an incentive to build up capital buffer in expansion that can be used to neutralise the effect of recession on capital requirements. To address this issue, Repullo and Suarez (2013) construct a model which shows that under risk-based capital requirements, banks hold larger buffers in expansion than in recession but these buffers were insufficient to prevent contraction in the supply of credit during recessions.

2.2.2 Determinants of bank capital buffer

Although Kashyap et al. (2004) and Repullo and Suarez (2013) provide a theoretical framework to analyse the interaction between capital buffers and the phases of business cycles, a consistent estimate of such interactions has to take into account the impact of other determinants of capital buffer. Following the partial adjustment model with quadratic cost of the adjusting capital suggested by Ayuso et al. (2004)

and Estrella (2004), the literature on banks' capital buffer, though diversified, tends to maintain a common set of explanatory variables. Banks return on equity (ROE) – a proxy for the cost of capital, bank size – often measured by banks' total asset, a risk variable – commonly proxied by some ratio of non-performing loans, and loan growth, are all utilised by, amongst others Brei and Gambacorta (2016), Coffinet et al. (2012), and Tabak et al. (2011).[7]

Holding excess capital involves a direct cost that has to be remunerated. This cost is approximated by institutions' ROE and is expected to have a negative sign. Milne (2004) argues that banks with a strong financial backing will demonstrate a negative relationship between capital buffers and ROE, pointing to the fact that exorbitant income acts as a substitute for capital buffer against unanticipated shocks. See also Ayuso et al. (2004), Jokipii and Milne (2008), and Tabak et al. (2011).

The relationship between the risk profile of an institution and its capital buffer is less clear. Salas and Saurina (2003) argue that for a risk averse institution there is a negative relationship between risk and the capital buffer, while for a low risk averse bank this relationship can be positive. They highlight the relationship between risk and capital buffer from a franchise value perspective. They argue that a decrease in franchise value of banks brings about an increase in the proportion of riskier loans. In this context, banks with a very low risk aversion may have an incentive to maintain a level of buffer capital that is closer to the regulatory minimum compared to more conservative banks. In contrast, Jokipii and Milne (2008) argue that for an ex-post measure of risk, such as non-performing loans to total loans ratio, a positive relationship is expected to be seen between risk and capital buffers. In particular they argue that for ex-post measures of risk, if banks' capital are consistent with their actual level of riskiness, then a positive relationship is expected to be seen with capital buffer.

[7] See also Ayuso et al. (2004), Boucinha et al. (2007).

Turning to loan growth, Ayuso et al. (2004) argue that an increase in loans implies an increase in capital requirements, and in a context where the cost of adjusting capital is very high, is likely to transitorily reduce capital buffers. Therefore, there is a much anticipated negative relationship between the growth of loans and banks' capital reserves. Earlier studies such as Sharpe et al. (1995) and Jackson et al. (1999) conclude that, at least in the short-run, adverse shocks to capital cause low-capitalised banks to cut back on new lending during recessions. Among others, Ayuso et al. (2004) highlight that big banks tend to hold relatively lower capital buffers, consistent with the well-known too big-to-fail hypothesis. In particular, these studies predict the bank's size and capital buffer move in the opposite direction (see Jokipii and Milne (2008), Coffinet et al. (2012) and Hancock and Wilcox (1998).

2.2.3 The link between the financial and business cycle

To gauge the cyclicality of capital buffers, a proxy reflecting the phase of the business cycle has to be constructed. A fundamental concept in both understanding and estimating a proxy of a business cycle is the potential output, defined as the level of output produced when available resources are fully and sustainably utilised. Potential output is unobserved and econometric estimation traditionally relies heavily on inflation. The conceptual association between inflation and the output-gap became so widely accepted that the literature has ignored the impact of financial variables on business cycle fluctuations. The basic idea was that deviation of actual output from the potential level will drive inflation. Therefore, inflation is the symptom of unsustainability. However, while variation of inflation might signal output deviation from its potential level, the pre-crisis experience indicates that this view might be myopic.

In particular, the recent financial crisis showed that low and stable inflation could coexist with unsustainable output growth, fuelled by the build up of financial imbalances. Even though inflation was low, credit and property prices grew at high levels, sewing the seeds for the last financial crisis. See Borio and Lowe (2002, 2004) for a pre-crisis analysis between asset prices development, financial stability and monetary stability. Borio et al. (2016) argue that there are four reasons for this. First, financial booms could coincide with positive supply shocks. This will lead to lower inflation and higher asset prices that weaken credit constraints. The ultimate result will be higher investment and economic growth and low inflation. The second reason stems from the fact that economic booms have the potential to weaken supply constraints either through higher participation rates or immigration. Injection of new capacity will boost economic growth without destabilising inflation. Third, financial booms are often associated with appreciation of the exchange rate, which puts a downward pressure on inflation. A final and frequently neglected point is that unsustainability may be generated by a sectoral misallocation of resources (see Borio et al. (2016)). Therefore, financial and real development might provide a wrong signal concerning the robustness of economic activity. A recession amplified by credit constraints make the recovery of economic growth a difficult task. Campello et al. (2010) and Drehmann et al. (2012) show that during downturns a debt-overhang magnifies the difficulty of labour and capital distribution. In so doing, the correction of resource misallocation build-up during the boom is hindered.

The fundamental implications of Borio et al. (2016) are that cyclical variation in output is influenced by financial developments. Therefore, it is important to account for the extent to which financial conditions have an impact (positive or negative) on the business cycle when a judgement about the sustainability of economic activity is formulated. From a measurement perspective, Borio et al. (2016) show that ignoring financial developments which may contain valuable information about the cyclical component of output, may produce a less reliable estimate of potential output. They argue that the crisis revealed that problems that originate in the financial sector can spill over and quickly permeate through sectors of the real economy and therefore further amplify initial economic shocks. It also revealed that there is insufficient literature on the identification of the financial cycle and its possible effects on the real economy. Borio et al. (2016) suggest a framework for measuring potential output that can be seen as an extension of a growing literature that seeks to investigate the link between, financial cycles, business cycle, and banking crisis (see Claessens et al. (2012); Aikman et al. (2015)). Based on the findings of Borio and Drehmann (2009) and Drehmann et al. (2012), Borio et al. (2016) extend a conventional standard HP-filter in a multivariate framework accounting for the impact of credit and property prices. In doing so, they compute the so-called "finance-neutral" potential output. They argue that this new "finance-neutral" output gap will: (i) show that, irrespective of how inflation behaved, actual output was much higher than potential before strong financial booms; (ii) be approximated with more precision; and most importantly, (iii) will be more robust in real time – that is, the real-time gap will be more in line with ex-post gap unlike other measures. This allows for real time detection of booms before the onset of the financial crisis.

2.3 Business cycles and finance-augmented business cycles

To gauge the impact of business cycle on capital buffers in this study, the analysis uses both univariate and multivariate statistical models. In particular, it applies the univariate HP filter and compare it to an unobserved component (UC) model, both in a univariate and multivariate framework. The next subsection presents a state-space representation. The study also implements the recent filter proposed by Hamilton (2017).[8] Despite its popularity, the HP-filter has some important drawbacks that should restrict its application. In particular, Hamilton (2017) argues that the HP-filter involves several levels of differences, so that for a random walk process, subsequent observed patterns are the by-product of having applied the filter rather than reflecting the underlying data generating process (DGP).[9] Hamilton shows that: i) the HP-filter produces spurious dynamics which are disconnected by the true DGP; ii) the HP-filter produces a cyclical component with observations at the end of the sample differing from those in the middle of the sample; iii) estimates of the smoothing parameter of the HP-filter produce values vastly at odds with the common practise.[10]

Hamilton (2017) suggests an alternative proxy for the cyclical component that avoids those problems. In particular, he assumes that the cyclical component of a possible non-stationary series should address the question of how different the value at time $t+h$ is from the value we expect to observe based on its behaviour at time t. Hamilton's proxy does not require knowing the nature of stationarity and to have the correct model to forecast the series. Instead, he establishes that we can run an OLS regression of y_{t+h} on a constant and the 4 most recent values of y_t.[11]

$$y_{t+h} = \beta_0 + \beta_1 y_t + \beta_2 y_{t-1} + \beta_3 y_{t-2} + \beta_4 y_{t-3} + v_{t+h} \tag{2.1}$$

[8] It also computes the band-pass filter suggested by Christiano and Fitzgerald (2003). Moreover, to correct for the uncertainty about these estimates at the sample end-points it follows the Watson (2007) methodology.

[9] Cogley and Nason (1995) show that HP filter can be approximated by taking the fourth-differences of the original data and then take a long, smooth weighted average of past and future values of these differences. See also King and Rebelo (1993).

[10] Hamilton (2017) wrote the HP-filter in a state-space form and estimates the smoothing parameter λ using maximum likelihood. Estimates of λ based on quarterly data were close to 1, therefore far away from the conventional $\lambda = 1600$.

[11] Proposition 4 of Hamilton (2017) provide a general framework of (4.1).

where the estimated residuals, $\widehat{v}_{t+h}$, offer a reasonable way to construct the transient component for a broad class of underlying processes. The proposed procedure has a number of advantages compared to the HP-filter. First, unlike the cyclical component of the HP-filter, $\widehat{v}_{t+h}$, is unpredictable.[12] Second, the value of $\widehat{v}_{t+h}$ is model-free. More formally, Hamilton (2017) argues that regardless of how the data have been generated, as long as $(1-L)^d y_t \leq 4$, there exists a population projection of y_{t+h} on $(y_t, y_{t-1}, y_{t-2}, y_{t-3}, 1)'$, which can be used to construct a cyclical component. Furthermore, for large samples, OLS estimates of (4.1) converge to $\beta_1 = 1$ and $\beta_j = 0$ for $j = 0, 2, 3,$ and 4. Therefore, the resulting filter becomes equal to the difference $\widetilde{v}_{t+h} = y_{t+h} - y_t$. Because $\widetilde{v}_{t+h}$ does not require estimation of any parameter it can be used as a quick check for $\widehat{v}_{t+h}$ being model free. Third, any correlation of $\widehat{v}_{t+h}$ with macro-variable x, reflects the true ability of y to predict rather than being an artefact of the filter. In light of this, this study accounts for Hamilton's suggestion and also produces a cyclical component given by $\widehat{v}_{t+h}$.

2.3.1 Unobserved Component Models

This section presents the univariate and multivariate UC model used to compute the business cycle and "financial-augmented cycle", respectively. In particular, it applies a version of the Clark (1987) unobserved component model to quarterly GDP, credit supply, house prices and credit-to-GDP ratio. To distinguish between trend and stochastic trend of real output, Clark (1987) considers the following unobserved component model:

[12] Hamilton (2017) show that an application of the HP filter to consumption and stock prices generates proxies of the cyclical component which were extremely predictable from their own lagged values as well as each other. Note, under the assumption that both consumption and stock prices follow a random walk process, then the first difference of these series, in line with the Hamilton (2017) approach, should be unpredictable.

$$y_t = n_t + x_t \tag{2.2}$$

$$n_t = g_{t-1} + n_{t-1} + v_t \tag{2.3}$$

$$g_t = g_{t-1} + w_t \tag{2.4}$$

$$x_t = \phi_1 x_{t-1} + \phi_2 x_{t-2} + e_t \tag{2.5}$$

where y_t is the log of real GDP, n_t is the stochastic trend and x_t is the stationary cyclical component; v_t, e_t and w_t are shocks that follow a white noise process. This study follows Clark (1987) in modelling the drift term (g_t) in the stochastic trend component as a random walk. Equations 2.3 to 2.5 can be written in state-space form to estimate a univariate UC model.[13] Assuming that the financial variables follow a unit root process, they can also be decomposed into trend and cyclical components:

$$z_{it} = L_{it} + C_{it} \tag{2.6}$$

$$L_{it} = L_{it-1} + v_{lit} \tag{2.7}$$

$$C_{it} = \alpha_{0i} x_t + \alpha_{1i} x_{t-1} + \alpha_{2i} x_{t-2} + e_{cit} \tag{2.8}$$

where i indicates the financial variables that are used to capture developments in financial markets.[14] L_{it} and C_{it} represent the permanent and cyclical component of the ith financial variable. Note that (2.8) allows the cyclical component of real

[13] For further details see equations 3.97 and 3.98 in Kim et al. (1999).

[14] $i = 1, 2$ in this specification, but it could be expanded to include a number of variables to capture the financial cycle.

GDP to influence the cyclical component of the financial variables but not vice versa. Here, it is assumed that expected output and lagged values of GDP will have an impact on the financial variables.[15] A state-space representation of (2.2) to (2.8) is given by:

$$\begin{bmatrix} n_t \\ x_t \\ x_{t-1} \\ x_{t-2} \\ g_t \\ L_{1t} \\ L_{2t} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & \phi_1 & \phi_2 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} n_{t-1} \\ x_{t-1} \\ x_{t-2} \\ x_{t-3} \\ g_{t-1} \\ L_{1t-1} \\ L_{2t-1} \end{bmatrix} + \begin{bmatrix} n_{vt} \\ e_t \\ 0 \\ 0 \\ w_t \\ v_{l1t} \\ v_{l2t} \end{bmatrix} \tag{2.9}$$

$$\begin{bmatrix} y_t \\ z_{1t} \\ z_{2t} \end{bmatrix} = \begin{bmatrix} 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \alpha_{01} & \alpha_{11} & \alpha_{21} & 0 & 1 & 0 & 0 \\ 0 & \alpha_{02} & \alpha_{12} & \alpha_{22} & 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} n_t \\ x_t \\ x_{t-1} \\ x_{t-2} \\ g_t \\ L_{1t} \\ L_{2t} \end{bmatrix} + \begin{bmatrix} 0 \\ e_{c1t} \\ e_{c2t} \end{bmatrix} \tag{2.10}$$

We can write (2.9) and (2.10) in compact form as follows:

[15] Note that data on GDP are published with a delay of at least one month after the end of the reference quarter. Thus, contemporaneous values of GDP will have an impact on future values of financial variables.

$$\begin{aligned} \mathbf{y}_t =& \mathbf{H}\xi_t + \mathbf{w}_t \\ & \mathbf{w}_t\tilde{\ } N(\mathbf{0}, \mathbf{R}_t) \end{aligned} \tag{2.11}$$

$$\begin{aligned} \xi_t =& \mathbf{F}\xi_{t-1} + v_t \\ & v_t\tilde{\ } N(\mathbf{0}, \mathbf{Q}_t) \end{aligned} \tag{2.12}$$

where (2.11) and (2.12) are the observation and measurement equations of the state-space model. Note that,

$$\mathbf{R}_t = \begin{bmatrix} 0 & 0 & 0 \\ 0 & \sigma^2_{e1t} & 0 \\ 0 & 0 & \sigma^2_{e2t} \end{bmatrix}$$

and

$$\mathbf{Q}_t = \begin{bmatrix} \sigma^2_{vt} & 0 & 0 & 0 & 0 & \sigma_{v1t} & \sigma_{v2t} \\ 0 & \sigma^2_{et} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \sigma^2_{wt} & 0 & 0 \\ \sigma_{v1t} & 0 & 0 & 0 & 0 & \sigma^2_{v1t} & 0 \\ \sigma_{v2t} & 0 & 0 & 0 & 0 & 0 & \sigma^2_{v2t} \end{bmatrix}$$

where σ^2_{eit} for $i = 1, 2$ is the observed variance of the financial variables, σ^2_{vt} and σ^2_{et} are the variances of the trend and cyclical component of real GDP, while σ^2_{vit} for $i = 1, 2$ indicates the variance of the trend component of the financial variables. The key extensions of this particular model are the covariances σ_{v1t}, and σ_{v2t} between the shocks affecting the trend component of real GDP and the trend component of the two financial variables included in the model. Unlike Clark (1987), this study allows shocks concerning the trend component of real GDP to be affected by shocks concerning the trend components of the financial variables. This is consistent with Borio et al. (2016), which explain that financial crises that follow a boom phase of the cycle, tend to permanently leave a negative impact on output, and therefore also on potential output. In particular, Borio et al. (2016) argue that the extent to which financial variables affect the cyclical component of output will significantly impact any approximation of potential output.

2.4 Data

There is no consensus in the literature about the variables to be included in the construction of a financial cycle and how to combine them in a single measure. Moreover, there is no agreement on the most reliable econometric method to analyse its statistical properties. This is frequently left to the personal preferences of the researcher. Ideally, one would like to extract a measure of the financial cycle by exploring information from a large number of variables across a large set of countries and a long time series. Some studies, such as Dell'Ariccia et al. (2012), Jordà et al. (2013) and Taylor (2015), among others, have used credit on the grounds that credit captures the boom-bust of the financial sector.[16] The Basel Committee published for consultation the countercyclical capital buffer (Committee et al., 2010), which suggested the credit-to-GDP ratio as a reference point that would drive the behaviour of the capital buffer.[17] However, the guidance document also warns about the possibility that this variable might give misleading signals. For further details see Repullo and Saurina Salas (2011).

[16] Among the type of credit, total credit has been shown to be relevant for the US, where credit to private non-financial sector, is not supplied by banks (see e.g. Dembiermont et al. (2013)).

[17] The rationale for the choice of the credit-to-GDP ratio as a reference point for taking buffer decision can be found in Drehmann et al. (2010).

Claessens et al. (2011) have a look at measures of credit and asset prices such as real estate and equity while Drehmann et al. (2012) used credit-to-GDP ratio, house prices and equity prices.[18] Note that Drehmann et al. (2012) identify the financial cycle with the joint fluctuations of credit, credit -to-GDP ratio and property prices. They omitted equity prices because they behave differently from house prices and credit variables. They argue that equity prices tend to exhibit far greater short-term volatility and their medium-term cycles are less associated with crises. Borio (2014) also argues that equity prices can be a distraction as they co-vary with the other variables much less. Furthermore, Drehmann et al. (2012) also show that equity prices have different characteristics from the other series according to a concordance index proposed by Harding and Pagan (2006). Stremmel (2015) also shows that for 11 European countries the best fitted financial cycle measure includes the following financial ingredients: credit-to-GDP ratio, credit growth and house prices-to-income ratio.

Following Borio (2014), Stremmel (2015), and Drehmann et al. (2012), this essay considers, along with GDP, three additional financial variables to construct both a measure of financial cycle and finance-augmented cycle. These are; (i) residential property prices; (ii) credit to the private, non-financial sector; and (iii) credit–to–GDP ratio. These variables are considered to be the most parsimonious way of capturing the financial cycle. In particular, using a multivariate unobserved component model, the study extracts a measure of the financial cycle from credit; credit-to-GDP ratio; and house prices. Alternatively, a measure of the finance-augmented cycle is computed by replacing credit with GDP.

The Gross Domestic Product (GDP) is obtained from the World Bank's World Development Indicators (WDI) database. Data on property prices, credit to non-financial sector, and credit-to-GDP ratio are retrieved from the BIS database. Data

[18]Drehmann et al. (2012) also highlight the usefulness of debt-to-GDP ratio.

on the consumer price indices (CPI) was also retrieved to deflate the series. All the series used to capture both cycles are in real terms (deflated by CPI) and in logs. The only exception is credit-to-GDP ratio, which is expressed in percentages. Further, the series are normalised to their respective values in 1985 to ensure comparability of the units. All macroeconomic data spans the period 1975 – 2015. This is a deliberate attempt to get the best possible approximation of the cyclical components and to avoid the well documented end-point problem associated with the use of statistical filters that are applied to the data.[19]

Figures 2.1 and 2.2 depict the output gap estimates derived using the unobserved component model.[20] We can observe the difference in amplitude between the finance–augmented cycles (labelled FAC_a and FAC_b) and the standard univariate business cycle. This is particularly evident during periods of financial booms. The key reason behind this difference is supported by the idea that developments in the financial sector has the potential to explain variations in the cyclical component of output.

[19] A typical issue with the use of the HP-filter is that it becomes asymmetric at the extremes of a time series. As such, the series are extended beyond the actual end date of 2014. The filter is then applied to the extended series to alleviate the end-point problem.

[20] Table A5 presents a cross-correlation matrix showing the various correlations among the different measures of the cycles.

Figure 2.1: Output gaps - Unobserved Components Model

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Source: Author's calculation. Notes: This figure shows the output gap movement derived using the unobserved component model for the G7 countries. The figure compares the output gap of the finance-augmented cycle and the business cycle. Components of FAC_a include GDP, property prices, and credit-to-GDp ratio.

Figure 2.2: Output gaps - Unobserved Components Model

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Source: Author's calculation. Notes: This figure shows the output gap movement derived using the unobserved component model for the G7 countries. The figure compares the output gap of the finance-augmented cycle and the business cycle. Components of FAC_b include private credit, property prices, and credit-to-GDp ratio.

2.5 Capital buffer: econometric methodology and data

Following the partial adjustment model with quadratic cost of adjusting capital suggested by Ayuso et al. (2004) & Estrella (2004), this study employs the following empirical model:

$$\begin{aligned} BUFF_{i,j,t} = {} & \mu + \alpha BUFF_{i,j,t-1} + \beta ROE_{i,j,t} + \gamma RISK_{i,j,t} + \delta SIZE_{i,j,t} + \theta CYCLE \\ & + \varphi \Delta LOAN + \phi_i + \theta_t + \epsilon_{i,j,t} \end{aligned} \tag{2.13}$$

where $BUFF_{i,j,t}$ indicates the capital buffer for bank i in country j in year t, ROE denotes return on equity, while $SIZE$ and $CYCLE$ are variables reflecting the size of the bank and the proxy of business cycle respectively. The lag of the dependent variable is used to capture adjustment cost and the sign of this coefficient is expected to be positive. ROE reflects the greater cost of capital funding relative to deposit or debt. The SIZE is included to detect differences in the buffer according to the size of each bank. $RISK$, the ratio of non-performing loans to total loans, is included since a bank's probability of failure is partially dependent on its risk profile. $\Delta LOAN$ denotes credit growth. $CYCLE$ represents the business cycle. It is the key variable of interest and is used to address the main question concerning the pro-cyclicality of capital buffers. Finally, ϕ_i is a bank fixed effect, θ_t is a time fixed effect and $\epsilon_{i},_{j}\ ,_{t}$ represents the error term.

The empirical analysis in equation (2.13) is based on an unbalanced panel, drawn from an international sample of 578 banks from 33 countries for the period 2000 to 2014.[21] I select banks by country in descending order of size (total assets) in order

[21]See Table A1 for details on the number of banks per country in the sample.

to capture the vast majority of the domestic banking system. Further, I restrict the sample to banks that record a minimum of eight consecutive observations for the dependent variable. The bank-level data are extracted from Bureau van Dijk's Bankscope which provides information on consolidated and aggregated statements of banks and their specialisation. There are two major advantages in using this source. First, the sampled banks account for up to 90 percent of the total assets in each country, hence providing a fairly comprehensive coverage. Second, the bank-level information is reported in standardised formats, after adjusting for country differences. Consolidated data is used for most banks. The scope of information provided by consolidated balance sheets is wider and information about banking subsidiaries operating outside of the home country is also included. In addition, consolidated data captures interdependence between macro factors and therefore make prudential data more consistent with real outcomes. Where consolidated data is not available, the aggregated data is used. The study focuses on three specific bank specialisations, namely; commercial, savings and co-operative banks. The main variable of interest is the capital buffer, which is the difference between the observed capital ratio of bank i in country j, in period t, and the Basel III minimum regulatory capital. Table 2.1 provides definitions of the variables used in the estimations while Table 2.2 provides some descriptive statistics for the sample of banks.

Table 2.1: Description of Variables

Variable	Description
BUFF	Total capital ratio minus Basel III regulatory minimum
RISK	Ratio of NPLs to Gross Loans
NET LOANS	Loans over total assets
SIZE	Natural log of total assets
ROE	Return on equity
PROFIT	Profit after tax over total assets
$\Delta LOAN$	Annual loan growth
BUSINESS CYCLE	Cyclical component of real GDP

Table 2.2: Descriptive statistics for regression variables

	Obs.	Mean	St. Dev.	Min	Max
Bank variables					
Buffer	6,363	6.021	5.316	-1.200	41.640
Return on equity	6,620	0.069	0.108	-0.606	0.317
Risk	5,989	4.699	5.398	0.000	89.980
Loan growth	6,333	9.536	17.698	-36.710	108.630
Macroeconomic variables					
Output gap (HP-filter)	8,220	0.0005	0.0292	-0.1456	0.1265
Output gap (Hamilton)	8,220	0.0013	0.0702	-0.5842	0.3968
Output gap (UC model) univariate	4,029	-0.0023	0.0072	-0.0335	0.0309
$Output\ gap_a$ (UC model) multivariate	4,029	-0.0015	0.0095	-0.0348	0.0167
$Output\ gap_b$ (UC model) multivariate	4,029	-0.0004	0.0095	-0.0287	0.0261

Notes: *Buffer* is the difference between the observed capital ratio of bank i in country j, in period t, and the Basel III minimum regulatory capital. *Return on equity* is the ratio of net income to equity. *Risk* is the ratio of non-performing loans to total loans. *Loan growth* is the growth rate of total loans. *Output gap* is the cyclical component of GDP derived from the HP-filter, Hamilton approach, and unobserved component model, respectively. The components of $Output\ gap_a$ are GDP, credit–to–GDP, and house prices. The components of $Output\ gap_b$ are private credit, credit–to–GDP ratio, and house prices.

It is worth noting, in (2.13) when the time dimension of the panel T is fixed, the Fixed Effect (FE) and Random Effect (RE) estimators are biased. This bias is known as Nickell bias, because it was Nickell (1981) who first showed that the FE estimator of α was biased. The Nickell bias is of order T and disappears only if $T \to \infty$. It could be large if T is small and α close to unity:

$$bias = -\frac{(1+\alpha)}{T} + O(T^{-2})$$

For further details see chapter 4 of Hsiao (2014) and chapter 27 of Pesaran (2015). Ample literature of consistent instrument variable (IV) and Generalised Method of

Moments (GMM) estimators have been proposed as an alternative for the FE estimator. Anderson and Hsiao (1981) suggest to remove the individual heterogeneity (i.e. ϕ_i) by taking the first difference and use the second lag of the dependent variable as an instrument for the differenced one-time lagged dependent variable. The IV estimation delivers consistent but not efficient estimates of the parameters in the model because it does not exploit all the available orthogonality conditions. Arellano and Bond (1991) argue that additional moments can be obtained by exploiting the orthogonality conditions that exist between the lagged values of the dependent variable and the disturbances. In particular, if $y_{it} = BUFF_{it}$ then we can write (2.13) as [22]

$$y_{it} = \alpha y_{it-1} + \beta' \mathbf{x}_{it} + v_{it} \tag{2.14}$$

where $i = 1, .., N, t = 1, ...T$, $\mathbf{x}_{it} = [ROE_{i,t}, RISK_{i,t}, SIZE_{i,t}, CYCLE,\ \Delta LOAN]'$ is a vector of possibly endogenous variables and $v_{it} = \phi_i + \epsilon_{i,t}$. Arellano and Bond (1991) suggest a GMM estimator to the stacked observations of

$$\Delta \mathbf{y}_{i.} = \alpha \Delta \mathbf{y}_{i-1} + \beta' \Delta \mathbf{X}_{i.} + \Delta \epsilon_{it} \tag{2.15}$$

where $\Delta y_{i.} = [\Delta y_{i2}, \Delta y_{i3}, ...\Delta y_{iT}]'$, $\Delta y_{i-1} = [\Delta y_{i1}, \Delta y_{i2}, ...\Delta y_{iT-1}]'$, $\Delta x_{i.} = [\Delta x_{i2}, \Delta x_{i3}, ...\Delta x_{iT}]'$, $\Delta \epsilon_{it} = [\Delta \epsilon_{i2}, \Delta \epsilon_{i3}, ..., \Delta \epsilon_{iT}]'$ and the number of instruments increases with each additional time period:[23]

$$dg(\mathbf{W}_i) = diag(y_{i1}, y_{i1}y_{i2}, ...y_{i1}y_{i2}...y_{iT-2})$$

$\mathbf{W}_i$ is a diagonal matrix of instruments. The moment conditions can be expressed compactly as $E(W_i' \epsilon_{it}) = 0$.

[22] For ease of exposition we dismiss the country indicator j.

[23] $\Delta = 1 - L$ is the difference operator.

However, Blundell and Bond (1998) and Binder et al. (2005) show that the IV and the one-step and two-step GMM estimators deteriorate as the variance of the individual effects ϕ_i increases relative to the variance of the error term $\epsilon_{i,t}$, or as the lag coefficient α approaches 1. In particular, the covariance of the lagged levels with the first-differenced variables (i.e. $E(\Delta y_{i-t-1}, y_{i,t-s})$ for $s > 1$) is an inverse function of α. Therefore, it is possible to show that the instruments $y_{i,t-s}$ are weakly correlated with the first differences Δy_{it}.[24] Blundell and Bond (1998) and Arellano and Bover (1995) get around the weak instrument problem by including in the set of instrumental variables not only the lagged levels but also the lagged differences of dependent variable. The original Arellano and Bond (1991) method is known as "difference GMM" while the expanded estimators are known as "system GMM". But as Pesaran (2015) points out, the number of orthogonality conditions $r = T(T-1)/2$ tends to infinity as $T \to \infty$. In this case, Alvarez and Arellano (2003) show that although the GMM estimators remain asymptotically normal, unless $\lim(T/N) = 0$, they become biased. This study circumvents the proliferation of instruments generated by the difference and system GMM by using as instruments only certain lags instead of all available lags. Furthermore, Monte Carlo studies by Hansen et al. (1996) and Arellano and Bond (1991) show that the estimated asymptotic standard errors of the two-step and iterated GMM estimators may have a severe downward bias in small sample, especially when the number of instruments is equal to or greater than the number of cross-sectional units (Beck and Levine (2004)). Windmeijer (2005) have proposed a finite sample correction for the estimates of the asymptotic variance. As such, this study ensures that for each specification, the number of instruments are fewer than the number of banks in the sample and

[24]For example, Pesaran (2015) shows that $E(y_{i,t-2}, \Delta y_{i,t-1}) = -\sigma_u^2(1-\alpha)\left(\frac{1-\alpha^{2(t-1)}}{1-\alpha^2}\right)$. It is clear that $y_{i,t-2}$ as an instrument will be weakly correlated with $\Delta y_{i,t-1}$ as α approaches to 1. Note that the IV/GMM approach breaks down for $\alpha = 1$. For further details see Pesaran (2015).

also apply Windmeijer's finite sample correction. Another important point to note is that the consistency of the GMM estimator depends on the errors being serially uncorrelated i.e., $E(\Delta\epsilon_{i,j,t}, \Delta\epsilon_{i,j,t-2} = 0)$. Hence, Arellano and Bond (1991) suggest to test that the second-order auto-covariances for all periods in the sample are zero.

The chosen instruments consist of the full complement of lags of the regressand ($BUFF$) and two to four lags of $RISK$ and ROE variables. These lags have been chosen to avoid correlation with the error term $\epsilon_{i,j,t}$ (which now appears in first differences) while simultaneously minimising the number of lost observations. Variables representing the business and financial cycles are treated as exogenous. The study reports two main post-estimation tests to validate the appropriateness of our dynamic GMM estimations. The first is the Hansen (1982) J test statistic for over-identifying restrictions. The J-test is related to the order condition of identification and tests the null that instruments being uncorrelated with the error term.[25] The other test is the Arellano-Bond test for autocorrelation of errors, as described above.

2.6 Empirical results

The study firsts examine the cyclicality of banks capital buffer using the full sample of banks. Subsequently, the impact of the finance-augmented business cycle on capital buffer is discussed. However, because of data-availability, the latter focuses only on G7 countries.

2.6.1 Traditional business cycles

Table 2.3 presents the results obtained from the estimation of the baseline model described in equation (2.13). The first two sets of results in Table 2.3 were carried out using the HP-filter to compute the cycle variable while the remaining two

[25] Failure to reject the null hypothesis indicates that the instruments are exogenous.

columns present the estimates of the capital buffer model where the Hamilton (2017) methodology was used to construct the proxy of business cycles.

Table 2.3: Baseline model

	(1) HP-Filter	(2) HP-Filter	(3) Hamilton	(4) Hamilton
$Buff_{i,j,t-1}$	0.460***	0.530***	0.483***	0.511***
	(0.091)	(0.077)	(0.093)	(0.081)
ROE	0.821	3.320***	1.928	3.545***
	(1.092)	(1.001)	(1.953)	(0.998)
Risk	0.276***	0.118*	0.137*	0.217***
	(0.083)	(0.069)	(0.078)	(0.069)
Size	0.003	0.486**	0.406	0.173
	(0.300)	(0.247)	(0.295)	(0.276)
$\Delta Loan$		-0.033***	-0.032***	
		(0.004)	(0.004)	
Business cycle	-4.235**	-3.994***	-2.251***	-3.449***
	(1.654)	(1.290)	(0.662)	(0.545)
$\alpha(1)$	0.00	0.00	0.00	0.00
$\alpha(2)$	0.66	0.40	0.49	0.27
Hansen J	0.06	0.09	0.06	0.26
Observations	4,508	4,468	4,320	4,471
No. of instruments	147	149	149	147
No. of Banks	577	577	577	577

Notes: This table provides results for the baseline specification of our model. The first two columns use a cyclical component of the output gap derived using the HP-filter. The final two columns use estimates of the output gap derived by the approach proposed in Hamilton (2017). The dependent variable (BUFF) is the bank's capital buffer ratio. All estimations are based on the Arellano and Bond (1991) difference GMM estimator. Robust standard errors are reported in parentheses, $\alpha(1)$ and $\alpha(2)$ are first and second order residual autocorrelation tests. The null hypothesis of the AR(2) test is that errors in the first-difference regression exhibit no second-order serial correlation. The null hypothesis of the Hansen test is that the instruments are valid. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 2.3 provides evidence that, after controlling for other determinants, there is a negative and significant relationship between the capital buffer and the phase of the business cycle. The estimated coefficients in columns (1) and (2) suggest that a 1% increase in the growth rate of GDP is associated with a decrease of approximately 4% in banks' capital buffer. In other words, as real economic activity declines banks build up their capital buffers. This implies that banks are more likely to hold more precautionary reserves during periods of uncertainty.[26] The bank specific controls also provide some interesting results. First, we focus on the cost

[26] The findings of Coffinet et al. (2012), Jokipii and Milne (2008) and Ayuso et al. (2004) are also consistent with this result.

of adjustment variable, i.e. the lagged dependent variable, which appears positive and significant in all four specifications. This finding is consistent with the view that the cost of capital adjustment is important in determining how much capital banks hold. The estimated coefficient on ROE in Table 2.3 appears positive and statistically significant in specifications (2) and (4). The positive impact of ROE on capital buffer indicates the importance that banks place on retained earnings to increase their capital buffer. Furthermore, the positive coefficient on $RISK$ in all four specifications suggests that banks with risky portfolios tend to hold more capital in reserve. Such behaviour would influence increases in total capital buffer and therefore has ramifications for the cyclical behaviour of bank capital. The impact of credit growth in columns (2) and (3) (i.e. $\Delta LOAN$) is significant at the 1% level and, as expected, enters with a negative sign. This suggests that a contemporaneous increase in credit growth reduces the capital buffer (Ayuso et al., 2004). Also, the study considers whether these results might be influenced by the fact that $\Delta LOAN$ could be a cyclical variable. If it is, it could influence the sign and significance on the business cycle variable. This is tested for each approach by excluding the $\Delta LOAN$ variable in columns (1) and (4). Finally, contrary to expectations, the bank $SIZE$ carries a positive and significant coefficient in column (2). Note that, consistent with the "*too big to fail*" hypothesis, it was expected that this coefficient would be negative, which would indicate that, ceteris paribus, larger banks tend to hold less capital in reserve. This will be investigated further with a split sample, separating big from small banks and carrying out separate estimations. The regressions pass both the Arellano-Bond test for autocorrelation of order 2 and the Hansen J test for over-identifying restrictions.

Table 2.4: Estimation by specialisation and size

	(1) Commercial	(2) Cooperative	(3) Savings	(4) Large	(5) Small
$Buff_{i,j,t-1}$	0.590***	0.468***	0.619***	0.628***	0.487***
	(0.061)	(0.091)	(0.117)	(0.068)	(0.088)
ROE	2.975**	3.058*	5.130**	0.138	4.032*
	(1.153)	(1.748)	(2.426)	(1.627)	(2.231)
$Risk$	0.097*	0.129***	0.089	0.293***	-0.064
	(0.053)	(0.045)	(0.074)	(0.109)	(0.147)
$Size$	0.467	-0.173	-0.537		
	(0.285)	(0.791)	(1.121)		
$\Delta Loan$	-0.035***	-0.026**	-0.036***	-0.017*	-0.088**
	(0.005)	(0.010)	(0.011)	(0.010)	(0.042)
$Business\ cycle$	-2.444***	1.237	-4.249*	-4.675**	0.771
	(0.533)	(0.872)	(2.442)	(2.030)	(1.828)
$\alpha(1)$	0.00	0.02	0.18	0.00	0.00
$\alpha(2)$	0.28	0.92	0.33	0.43	0.40
Hansen J	0.06	0.98	0.52	0.75	0.73
Observations	2,992	270	318	401	1,119
No. of instruments	69	35	43	43	52
No. of banks	433	41	50	65	203

Notes: This table provides results by bank specialisation and size. The first, second and third columns highlight the results for commercial, cooperative and savings banks, respectively. The fourth column provides results using large banks. Large banks are those that fall in the highest decile of the size distribution of total assets. The fifth column provides results for small banks, those that fall in the lowest 30 percentile of the size distribution. The cycle variable used in each specification is derived using the Hamilton (2017) approach. The dependent variable (BUFF) is the bank's capital buffer ratio. All estimations are based on the Arellano and Bond (1991) difference GMM estimator. Robust standard errors are reported in parentheses, $\alpha(1)$ and $\alpha(2)$ are first and second order residual autocorrelation tests. The null hypothesis of the AR(2) test is that errors in the first-difference regression exhibit no second-order serial correlation. The null hypothesis of the Hansen test is that the instruments are valid. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Next, the study considers the possibility that the capital ratios of different types (commercial, savings and co-operative) and size of banks may react differently to business cycle conditions. It classifies big banks as those that fall in the highest decile of the size distribution of total assets, while small banks are those that fall in the lowest 30 percentile of the size distribution. Table 2.4 reports estimates accounting for the type and size of banks. It first discusses results concerning the type of banks as presented in the first three columns of Table 2.4. Although there is still evidence of pro-cyclicality in capital buffers for commercial and savings banks, for co-operative banks the cycle enters with a positive coefficient, albeit statistically insignificant. These results suggest that the pro-cyclicality of capital buffers observed in Table 2.3 is being driven by commercial and savings banks. The study takes into consideration the possibility that the results concerning savings banks could be driven by the relatively small number of observations. However, using a sample of nearly 500 German savings banks (4346 observations), Stolz and Wedow (2011) find that the capital buffer of these banks are negatively associated with the cycle. The consistency of the findings in this study with those of Stolz and Wedow (2011) eases this concern regarding the small sample size. The $\Delta LOAN$ is negative and significant across all bank types, with the sensitivity approximately being the same for all three categories. Therefore, irrespective of product specialisation, credit growth will have a negative impact on capital buffer. The $RISK$ coefficient remains positive for all three categories, but statistically insignificant for savings banks. The impact of bank $SIZE$ on capital buffer is in line with results in Table 2.3 as it remains insignificant across all types of banks. Next the study analyses estimates accounting for the bank size as presented in the last two columns of Table 2.4. In these two specifications $SIZE$ is removed from the setup. As expected, the $CYCLE$ variable for big banks carries a negative sign, while for small banks it carries a positive but insignificant coefficient. This is consistent with the *too-big-to-fail* hypothesis.

To summarise the results using the business cycle as the cyclical indicator, the study finds evidence of pro-cyclicality in capital buffer. The pro-cyclicality of capital buffer is driven by commercial and savings banks, but the impact is more significant for commercial banks. Big banks display pro-cyclicality in capital buffer while for smaller banks, the evidence suggests that capital buffer is not pro-cyclical.

2.6.2 Finance-augmented business cycles

This section discusses the results of the relationship between a bank's capital buffer and the financial-augmented output gap as the cyclical indicator. Given the limited availability of data, the sample is restricted to the G7 countries. Though reduced, the sample remains sufficiently large enough to carry out the estimations.

For comparability, in column (3) of Table 2.5, the paper also presents the results for the univariate business cycles computed using the UC model. As previously mentioned in section 2.4, the study derives two measures of a finance-augmented cycle (presented as FAC_a and FAC_b in Table 2.5) using a multivariate unobserved components model. The model composition of FAC_a includes GDP along with two financial sector variables. As a credit aggregate, it uses credit-to-GDP ratio as a proxy for leverage, and property prices as a measure of available collateral. FAC_b comprises of private credit growth, credit-to-GDP ratio and property prices. The estimations maintain all the bank-specific control variables and simply replace the cycle indicator in the model. The findings are presented in Table 2.5 below.

Table 2.5: Estimation using G7 countries

	(1) HP	(2) Hamilton	(3) UC Model	(4) Multivariate UC Model	(5) Multivariate UC Model	(6) Multivariate UC Model
$Buff_{i,j,t-1}$	0.635***	0.643***	0.498***	0.692***	0.605***	0.716***
	(0.060)	(0.062)	(0.0756)	(0.0813)	(0.079)	(0.085)
ROE	4.230***	4.435***	4.847***	5.167***	4.458***	5.767***
	(1.078)	(1.062)	(1.216)	(1.315)	(1.172)	(1.234)
Risk	0.221**	0.221**	0.242***	0.249**	0.170***	0.264***
	(0.097)	(0.097)	(0.081)	(0.104)	(0.065)	
Size	0.479	0.341	0.465	0.299	0.329	0.115
	(0.371)	(0.354)	(0.432)	(0.500)	(0.495)	(0.529)
$\Delta Loan$	-0.033***	-0.033***	-0.035***	-0.031***	-0.041***	-0.031***
	(0.006)	(0.006)	(0.009)	(0.006)	(0.010)	(0.006)
Business cycle	-5.829***	-2.677***	-7.301*			
	(1.650)	(0.797)	(4.260)			
FAC_a				-12.080***		-11.178***
				(4.049)		(3.802)
FAC_b					-16.677**	
					(8.327)	
Crisis						0.196
						(0.159)
$\alpha(1)$	0.00	0.00	0.00	0.00	0.00	0.00
$\alpha(2)$	0.67	0.59	0.39	0.29	0.88	0.33
Hansen J	0.94	0.98	0.10	0.91	0.56	0.92
Observations	2,540	2,540	2540	2,324	2,324	2,324
No. of instruments	132	132	132	132	118	133
No. of banks	281	281	281	281	281	281

Notes: This table provides results for G7 countries using cyclical approaches from the HP-filter, Hamilton (2017), and the unobserved component model. The dependent variable (BUFF) is the bank's capital buffer ratio. FAC_a: components (GDP, credit-to-GDP ratio, house prices); FAC_b: components (Private credit, credit-to-GDP ratio, house prices). All estimations are based on the Arellano and Bond (1991) difference GMM estimator. Robust standard errors are reported in parentheses, $\alpha(1)$ and $\alpha(2)$ are first and second order residual autocorrelation tests. The null hypothesis of the AR(2) test is that errors in the first-difference regression exhibit no second-order serial correlation. The null hypothesis of the Hansen test is that the instruments are valid. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Focusing on columns 4 and 5, where the new cyclical measures are introduced, negative coefficients are once again observed, but they are much more sensitive, as reflected by their magnitude.[27] Therefore, capital ratios are even more pro-cyclical when we account for financial sector developments in the business cycle. With respect to the other determinants, the signs of the coefficient are predominantly the same. The study also tests the direct impact of the financial crisis on capital buffer. It does so by introducing a crisis dummy which takes the value of 1 in the years 2008-2012 and 0 otherwise. This crisis dummy returned statistically insignificant. Note that the crisis dummy reflects the impact of a structural break, and as such it is considered exogenous and unpredictable. Therefore, it is not surprising that the crisis dummy does not have a significant impact on the capital buffer.

In an attempt to attenuate the possibility that the argument of more pro-cyclical might simply be as a result of scaling, I compute the marginal effects of each of the cyclical variables in Table 2.5. These effects are presented in Table A5. The results, however, suggest a general negligible effect. However, a further attempt to alleviate fears of scaling issues proved more successful using standardised versions of the cyclical variables. I standardise all cyclical variables used in Table 2.5 and re-estimate each specification. These results are presented in Table A3. Results from these estimations are broadly consistent with the main findings. Specifically, model 4 provides evidence that the response of capital buffer to the finance-augmented cycle is stronger than the response to the standard cycles.

[27]Before doing any estimations with the new cyclical measure, the study first runs regressions using the business cycle to ensure the results are consistent (with the full sample in Table 2.3) using the G7 sample. The results, as shown in columns 1 and 2, are largely consistent with that of the full sample in Table 2.3. In addition, a further specification using the Christiano-Fitzgerald filter to estimate the output gap, is presented in Table A2 of the appendix.

Table 2.6: Estimation by specialisation and size using G7 Countries

	(1) Commercial	(2) Cooperative	(3) Savings	(4) Large	(5) Small
$Buff_{i,j,t-1}$	0.712***	0.362**	0.673*	0.688***	0.803***
	(0.096)	(0.144)	(0.343)	(0.086)	(0.103)
ROE	4.409***	5.804	4.803	3.420**	3.898*
	(1.349)	(3.512)	(5.022)	(1.480)	(2.300)
$Risk$	0.136*	0.111*	0.015	0.394***	0.113
	(0.080)	(0.061)	(0.179)	(0.114)	(0.166)
$Size$	0.871**	0.020	3.049		
	(0.408)	(0.926)	(2.881)		
$\Delta Loan$	-0.050***	-0.023	-0.076	-0.016	-0.095***
	(0.014)	(0.016)	(0.044)	(0.010)	(0.028)
FAC_a	-11.917***	7.720	14.427	-23.788**	8.867
	(4.138)	(10.967)	(23.240)	(10.849)	(9.053)
$\alpha(1)$	0.00	0.07	0.12	0.00	0.00
$\alpha(2)$	0.49	0.91	0.31	0.19	0.49
Hansen J	0.24	0.96	0.44	0.75	0.40
Observations	2,013	212	126	322	527
No. of instruments	96	43	16	64	51
No. of banks	228	30	14	56	78

Notes: This table provides results by bank size and specialisation. The first column provides results using large banks. Large banks are those that fall in the highest decile of the size distribution of total assets. The second column provides results for small banks, those that fall in the lowest 30 percentile of the size distribution. The third, fourth and fifth columns highlight the results for commercial, cooperative and savings banks, respectively. The cycle variable used in each specification is derived using the unobserved component model. The dependent variable (BUFF) is the bank's capital buffer ratio. FAC_a: components (GDP, credit-to-GDP ratio, house prices). All estimations are based on the Arellano and Bond (1991) difference GMM estimator. Robust standard errors are reported in parentheses, $\alpha(1)$ and $\alpha(2)$ are first and second order residual autocorrelation tests. The null hypothesis of the AR(2) test is that errors in the first-difference regression exhibit no second-order serial correlation. The null hypothesis of the Hansen test is that the instruments are valid. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 2.6 provides a comparable breakdown to Table 2.4. It examines the cyclical behaviour of banks' capital buffer by size and specialisation using the G7 sample. Similar to the results of Table 2.4, the capital reserves of big banks are pro-cyclical, whilst there is no evidence to suggest the same for smaller banks. Furthermore, there is evidence that only commercial banks exhibit this pro-cyclical behaviour. In summary, the results based on the finance-augmented cycle are broadly consistent with those of the business cycle. The pro-cyclicality of capital ratios appear, however, significantly stronger over the finance-augmented cycle.

2.6.3 Robustness

This section discusses the robustness checks done on the empirical approach to ensure that the key results are consistent. To do this, the study replicates estimations from Table 2.3 and Table 2.5, using the Arellano and Bover (1995) system GMM estimator. The system GMM estimator tends to perform well in the presence of highly persistent variables. The results are shown in Table 2.7 of the Appendix. All the main results remain largely consistent with those presented in the previously mentioned tables. The cyclical indicators remain negative and significant throughout.

Table 2.7: Robustness checks using system GMM estimator

	(1) Hamilton	(2) Hamilton (G7)	(3) UC Model
$Buff_{i,j,t-1}$	0.738***	0.933***	0.928***
	(0.055)	(0.044)	(0.040)
ROE	5.594***	4.016**	5.348***
	(1.991)	(1.566)	(1.961)
$Risk$	0.092**	0.106***	0.104***
	(0.037)	(0.039)	(0.033)
$Size$	-0.056*	-0.026	-0.021
	(0.032)	(0.024)	(0.032)
$\Delta Loan$	-0.031***	-0.034***	-0.060***
	(0.004)	(0.006)	(0.013)
Business cycle	-3.202***	-4.567***	
	(0.486)	(0.776)	
FAC_a			-15.669***
			(3.555)
Constant	1.562***	0.290	0.320
	(0.568)	(0.352)	(0.453)
$\alpha(1)$	0.00	0.00	0.00
$\alpha(2)$	0.20	0.59	0.36
Hansen J	0.06	0.07	0.46
Observations	5,001	2,925	2,631
No. of instruments	87	166	149
No. of banks	577	281	281

Notes: The dependent variable (BUFF) is the bank's capital buffer ratio. FAC_a: components (GDP, credit-to-GDP ratio, house prices). All estimations are based on the Arellano and Bover (1995) system GMM estimator. Robust standard errors are reported in parentheses, $\alpha(1)$ and $\alpha(2)$ are first and second order residual autocorrelation tests. The null hypothesis of the AR(2) test is that errors in the first-difference regression exhibit no second-order serial correlation. The null hypothesis of the Hansen test is that the instruments are valid. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Further, the study also considers the fact that expectations might affect how and when banks adjust their capital buffer. The question of whether banks react to expected changes in regulation remains largely unexplored. This issue raises concerns about the understanding of banks' behaviour, especially during times of significant regulatory change. For example, expectations of forthcoming policy changes might lead to earlier reactions by banks. To test this, the study creates dummy variables to represent the announcement dates of the Basel Accords. In June 1999, the Basel Committee issued a proposal for a new capital adequacy framework to replace the 1988 Accord. This led to the release of a revised capital framework (Basel II) in June 2004. The announcement of Basel III was made in 2010, and subsequently its implementation began to phase-in in 2013. With the current dataset spanning the period 2000 - 2014, it captures the announcement of both Basel II and Basel III capital standards requirements.

As such, the study uses an event study to test whether these announcement dates were significant in determining the timing and nature of adjustment of banks' capital buffer. These announcements turn out to be statistically insignificant. There are two possible reasons for this. First, the frequency of the data used in this study might not allow for accurately capturing the expectation effects. Banks are likely to make adjustments to their buffer stock over monthly or quarterly intervals, in anticipation of a policy change. The second reason is that the implementation process of Basel capital regulations is not homogeneous across countries. Some countries or regions are much slower in implementing these regulatory changes than others, which makes it difficult to capture the effect of expectations or anticipation across this panel data.

2.7 Conclusion and Policy Implications

This study examines how the capital buffers of banks behave over the business cycle. The study uses two cyclical measures to examine this behaviour. It relies on the widely used business cycle measure, proxied by GDP, and also introduces a novel approach in the form of a finance-augmented cycle. The study applies the Arellano-Bond GMM difference estimator to control for adjustment costs, unobservable heterogeneity and potential endogeneity of the explanatory variables. The essay is unique in two ways. First, it differs from much of the empirical literature on banks' capital buffer, as most of these studies focus on a single country. This study uses panel data and provides results for countries across all three income levels. Second and more importantly, the majority of this literature solely focus on the business cycle, disregarding the potential impact of financial sector activities. This analysis uses a proxy of the business cycle which accounts for developments in the financial sector. The inclusion of information about the financial side of the economy can provide more reliable estimates of the output-gap than the conventional filter-based approach used in the literature.[28]

The results indicate a negative relationship between the capital buffer and the business cycle. That is, during an economic downturn banks increase their capital buffer, whilst in booms they reduce it. Furthermore, it finds that this negative relationship is particularly related to large banks. The reason for this is owing to the fact that Global Systemically Important Banks (G-SIBs) or big banks hold less capital with the expectation that, in the event of a financial crisis, they will inevitably be bailed out. On the other hand, small banks are more reliant on retained earnings as a protection against insolvency, as such, they increase capital buffer during booms. Further analysis indicates that this negative relationship is being driven by commercial and savings banks, with the former being more sensitive to the business cycle. The results also highlight that capital ratios are even more pro-cyclical when using a finance-augmented output gap. While it is understood that the task of disentangling credit cycles from business cycles and measuring both accurately is quite difficult, it is important to capture as much information about the financial sector if we are to discover the true impact of macroprudential regulation.

An important implication of these findings is the key role of monetary authorities

[28]For further details on reliable estimates of output-gap accounting for the information of financial variables see Borio et al. (2016).

in the supervision of risk management practices. Particularly, from a macroprudential policy standpoint, regulators should adopt more flexible instruments to mitigate credit risk in banks globally. This recommendation is motivated by the fact that even with the prudential framework set out in the new Basel accords (Basel III), the pro-cyclical behaviour of banks' capital buffer will still persist.

The analysis in this study shows that it is not always safe to assume that regulatory or supervisory capital standards automatically constrain banks. Market power, for example, may induce banks to hold capital in excess of the minimum required, thereby reducing the power of capital requirements as instruments of financial stability.

A major step towards mitigating the pro-cyclical impact of capital ratios is the introduction of capital conservation buffer (countercyclical capital buffer). This particular tool is designed to ensure that banks build-up sufficient capital buffers in the banking system during booms and to encourage their use during stressful periods, thereby easing the strains on credit supply. The finding of a greater degree of pro-cyclicality of banks' capital ratios would suggest that the approach to setting the countercyclical capital buffer rate for banks might need to be more rigid.

Chapter 3

Corporate Tax-Shields and Capital Structure: Levelling the Playing Field in Debt vs Equity Finance

3.1 Introduction

The recent global financial crisis demonstrated that bank capital structure is one of the most important determinants of financial stability, as better capitalized banks tend to be more resilient to economic and financial shocks. Consequently, regulators have significantly focused their atention on banks capital adequacy in order to enhance the stability of the financial system. The realization of this importance has prompted many researchers to try to identify and understand the determinants of bank capital structure. An often overlooked or underestimated determinant is corporate income taxation; interestingly, studies have shown that taxation was one of the possible sources that might have indirectly contributed to the 2008 financial crisis (see for e.g. De Mooij (2012), Turner (2010)). Yet, there is scarce evidence on the impact of corporate taxation on bank stability, with most of the existing literature focusing on the relationship between taxes and leverage.[1] Previous work on capital structure focuses primarily on bank-specific factors. As a consequence, the question of whether corporate taxes play a crucial role in the capital structure decisions of banks remains largely unanswered. This essay seeks to address this gap in the literature by examining the impact of corporate tax shields on the capital structure of banks.

As Schepens (2016) points out, one particular challenge in empirically analysing the impact of tax shields on bank capital structure is that tax shields are generally constant over time, and marginal tax rates tend to be endogenous. That is, changes to the tax rate are usually part of a broader tax reform, which then makes it difficult to isolate the direct impact of the tax shield. To circumvent this, this study exploits an exogenous change in corporate tax laws in Italy in 2012 that tackled this tax

[1] See DeAngelo and Masulis (1980), Dwenger and Steiner (2014),Heckemeyer and de Mooij (2017).

advantage of debt finance by introducing an allowance for corporate equity.[2] The introduction of this ACE allows for examining the direct impact of a tax shield for equity on bank capital structure, the implications it has for the risk-taking behaviour of these banks, and finally, the important role this tax shield has to play in the make up of tools available to prudential regulators.

The analysis yields several distinct set of results. First, it finds that treated banks which have been affected by this new tax regulation, significantly increase their capital ratios by approximately 8.5%. The main intuition behind this finding is that the ACE ensures a cut in the effective tax ratio (tax liability on profit), hence freeing up resources. As a result, banks can now rely more on internal or external equity and less on leverage. This result is corroborated by the 'trade-off theory' for capital structure, as the creation of a tax shield for equity reduces the marginal benefit of debt. Second, it finds that this reaction by banks to the tax shield is homogeneous. That is, both high- and low-capitalized banks increase their equity ratios following the implementation of the tax shield.[3] Third, the study examines the main factors influencing this change in the equity ratios. By definition, bank equity ratios can increase either by increasing their equity, or by reducing their assets, or indeed by a combination of both. The results reveal that the observed increase in equity ratios is as a result of an increase in common equity rather than a reduction in assets. This result is of paramount importance due to the far reaching implications had it been as a result of a reduction in bank activities. Empirically, it confirms that the increase in equity ratios is due to the exogenous change in corporate tax laws, which reduces the tax debt bias. However, more importantly, it dismisses any concerns about the treatment having any pro-cyclical effect. The recent financial

[2]The Italian ACE was presented by the government in December 2011 and decreed by the Ministry of Economy and Finance in March 2012.

[3]Banks are regarded as being highly-capitalized if they have an equity-to-assets ratio that is in the 75th percentile of the size distribution. Those with equity ratios below the median are classified as low-capitalized or financially more constrained.

crisis demonstrated that higher capital requirements could potentially harm the real economy if they significantly reduce bank loan provision.[4] This finding can also relax any concern about the observed changes in equity ratios being as a result of a reduction in loan demand, since the ACE was also enforced for non-financial firms (see Célérier et al. (2017)).

Finally, examining the risk-taking behaviour of the banks, this essay documents that not all treated banks react in a similar manner. The reaction depends on how well capitalized the banks are. Only under-capitalized banks reduce their level of riskiness (as measured by a non-performing loans ratio). The study finds that, following the introduction of the ACE, ex-ante high-capitalized banks increase their riskiness.

Overall, the results in this essay illustrate that both ex-ante high and low-capitalized banks adjust their capital structure in a similar manner following the introduction of the allowance for corporate equity. However, the risk-taking behaviour is heterogeneous across these bank types, as only ex-ante low-capitalized banks reduce their riskiness.

This essay therefore builds on two broad strands of the literature. First, it adds to the literature discussing the determinants of banks' capital structure, and capital structure decision (see amongst others; Gropp and Heider (2010), Allen et al. (2015), and De Jonghe and Öztekin (2015)). More importantly, it also contributes to the burgeoning literature surrounding the introduction of a tax shield for equity, to reduce the relative tax advantage of debt (see for example; Schepens (2016), Célérier et al. (2017), and Panier et al. (2013)). By focusing on the Italian banking sector, this paper builds on the findings of Schepens (2016) by evaluating the robustness of an ACE as a new macroprudential policy tool. While Panteghini et al. (2012)

[4]There is also an extensive literature on the potential pro-cyclical effects of capital requirements. See for e.g. Jokipii and Milne (2008), Coffinet et al. (2012), Shim (2013), and Brei and Gambacorta (2016).

tested the impact of an ACE on Italian firms, the focus on banks in this study serves to contribute to the macroprudential debate, particularly regarding the design of countercyclical policy tools. The nature of Italy's banking system and the timing of the introduction of the ACE make the findings of this study even more relevant for policymakers. Unlike Belgium, the Italian banking sector suffered from the Eurozone government debt crisis which began in 2010 - a delayed unfolding of the global financial crisis. Italy's economy also performed poorly in the years preceding the crisis and held a very high debt-to-GDP ratio. Further, Italy's ACE was implemented after the global financial crisis whilst Belgium's tax reform was in 2006. These particular features of Italy's banking sector and economy provide an ideal opportunity to test the robustness of the ACE as a potential macroprudential policy tool.

The remainder of this essay is organised as follows. Section 3.2 gives an extensive overview of the literature. Section 3.3 describes the Italian ACE system and develops the hypotheses to be tested. Section 3.4 describes the data and empirical method used. Section 3.5 discusses the results from the empirical analysis. Section 3.6 concludes.

3.2 Literature overview

There is an ongoing debate on the role taxes play in the capital structure decision of institutions. In the mid-1970s, the general academic view was that the optimal capital structure involves balancing the tax advantage of debt against the present value of bankruptcy costs. Miller (1977) presented a new challenge by showing that under certain conditions there is a trade-off in tax advantage between the firm and household. That is, the tax advantage gained by firms through debt finance is exactly offset by the tax disadvantage of debt at the household level. Since then, studies have sought to reconcile Miller's finding with that of the balancing theory. Beyond this, a number of studies have attempted to explain the role taxes play in determining capital structure.

In an early paper, Fischer et al. (1989) use a continuous-time framework to measure capital structure choice. The model derives closed-form solutions for the value of a firm's debt and equity as a function of its dynamic recapitalization decisions. The results from the model highlight the risks of viewing observed debt ratios as "optimal", and as such use the range over which the firm allows its debt ratio to vary as the measure of capital structure relevance instead. In doing so, the model then provides distinct predictions relating firm-specific properties to the range of optimal leverage ratios. Smaller, riskier, lower-tax, lower-bankruptcy-cost firms will exhibit wider swings in their debt ratios over time. Other earlier studies that contribute to this debate include, among others, DeAngelo and Masulis (1980); Ang and Peterson (1986); Titman and Wessels (1988); Graham (1996a) and Graham (1996b).

Within the banking literature, most studies on capital structure mainly focus on the bank-specific factors that affect bank capital structure (see for e.g. Flannery and Rangan (2008); Berger et al. (2008); Gropp and Heider (2010); Antoniou et al. (2008)). Interestingly, Gropp and Heider (2010) find that unobserved time-invariant bank fixed effects are the most important determinants of banks' capital structures and that mispriced deposit insurance and capital regulation were not as important in determining the capital structure of large U.S. and European banks. Octavia and Brown (2010) on the other hand argue that the standard determinants of capital structure do provide explanatory power with regards to the variation in both bank and market capital above the minimum requirement. Adding that when asset risk is controlled for, the overall significance of the standard determinants of bank capital structure choice is unchanged. The authors however, focused solely on 10 selected developing countries.

Diamond and Rajan (2000) posit that in order to truly understand the determinants of bank capital structure, it is important to firstly model the essential functions that banks perform, and then ask what role capital plays. This approach demonstrates that a bank's capital structure affects both its ability to create liquidity and credit, and also its stability.

Other studies within the literature tend to focus on how banks make capital structure adjustment. To assess the cyclical behaviour of European bank capital buffers, Jokipii and Milne (2008) rely on the 'standard' determinants of bank capital. That is, they control for banks' risk behaviour, size, and profitability - and then demonstrate that banks tend to reduce capital in business cycle expansions and increase capital in recessions. Lepetit et al. (2015) use similar bank-specific controls along with market discipline and ownership to test whether banks' capital ratios are affected by the degree to which control rights are exercised by owners in pyramids. The finding suggests that banks' decisions on how to move to target capital ratios vary according to the presence or absence of excess control rights. In the absence of excess control rights, banks build their capital ratios by issuing equity and by readjusting their assets without curtailing lending. In fact, these banks reduce their capital ratios by repurchasing equity and lowering retained earnings and by expanding their assets, particularly through lending. On the other hand, in the presence of excess control rights, banks adjust by repurchasing equity when they are above the target capital ratio. Of note, Lepetit et al. (2015) point out that instead of issuing equity, these controlled banks increase their capital ratio by pulling on earnings and by reducing their assets, particularly, their lending.

Using a partial adjustment framework with bank-specific and time-varying targets to model bank capital ratios, De Jonghe and Öztekin (2015) present some distinctive findings regarding how banks adjust their capital. They show that these adjustment decisions not only reflect the characteristics of the bank, but also the environment in which it operates. They find that speed of capital structure adjustment is heterogeneous across countries. Specifically, in countries where there are more developed capital markets, stringent capital requirements and supervisory monitoring, and high inflation, banks tend to make faster capital structure adjustments. Also, banks make capital structure adjustments significantly faster during crisis periods.

Contributing to the debate on the design and calibration of international capital standards, Francis and Osborne (2012) find that capital requirements that include firm-specific, time-varying add-ons set by supervisors affect banks' desired capital ratios. They argue that as a result of this, the adjustments to capital and lending depend on the gap between actual and target ratios. More importantly, their results suggest that the impact of countercyclical capital requirements may be dampened in trying to slow credit activity when banks can readily satisfy them with lower-quality capital elements versus higher-quality common equity. In a similar study Memmel and Raupach (2010) find that there is a high level of variation in capital ratios across banks, but less so across non-financial firms. Further, they find that private commercial banks and banks with a high degree of proprietary trading tend to make tighter adjustments to their regulatory capital ratios.

While there is a wide range of work on capital structure adjustments, the impact of corporate tax rates on these adjustments is far less researched. The exisiting literature on tax rates and leverage mainly looks at the correlation between the two on a cross-country level. Keen and de Mooij (2012) explore the impact of corporate tax bias on bank leverage and regulatory capital ratios for a panel of over 14,000 commercial banks across 82 countries over the nine year period 2001-2009. They explore various forms of heterogeneity by estimating a second-order polynomial with interactions of bank characteristics and the tax effect on leverage. Their findings suggest that responses differ only by bank size. They find that large banks (usually more highly leveraged), are less responsive to tax than small banks. This finding concurs with the 'too-big-to-fail' hypothesis. Large banks being less responsive to tax changes than smaller banks highlights their status that lowers their cost of debt finance, inducing them to become more highly leveraged and leaving less scope for tax effects. In a related study, De Mooij et al. (2013) show the implications of corporate tax systems favouring debt finance over equity finance. They argue that greater tax bias is associated with significantly higher aggregate bank leverage, and this then translates to greater risk of crisis.

Horváth (2013) uses GMM to estimate the effect of corporate income taxation on bank capital structure and risk. Consistent with the literature, he finds that an increase in the tax rate leads to an increase in the leverage ratio and a reduction in average risk-weighted assets. Similar to Keen and de Mooij (2012), Gu et al. (2015) find that banks that are subject to more stringent capital requirements are less responsive to tax. More specifically, they find that there are two channels through which a bank's leverage depends on corporate income taxes. The first is the 'the traditional debt bias', which is measured by the debt impact of the local tax level in the host country of a subsidiary. The second is via 'international debt shifting', which measures the debt impact of the cross-border tax difference vis-a-vis other bank subsidiaries in the same multinational group. The study shows that the impact of the tax effect is significant via both channels. However, the international debt shifting effect is stronger. Thus, they suggest that tax policies worldwide induce a large share of international debt structure changes through their impact on multinational bank behaviour.

Adding to this body of literature also is Hemmelgarn and Teichmann (2014), whose findings are largely consistent with previous studies. The authors examine the effect of tax rate changes on leverage, dividend policies and earnings management of banks, with results suggesting a significant impact on all three. Most importantly, they find that leverage increases with the corporate income tax (CIT) reform within the first three months of its implementation. They cite as the main reason, the fact that a higher tax rate increases incentives to use debt finance when interest payments are deductible from the CIT base.

An exception to the cross-country study is Schandlbauer (2017). He adopts the difference-in-differences methodology to show the impact of changes in local state corporate tax rates in the United States affect banks' financing as well as their operating choice. His study exploits U.S. bank holding companies that were subject to 13 distinct state tax increases between 2000-2011. He finds that as a result of the tax increase, banks significantly increase their non-depository leverage ratio, pointing to the fact that they benefit from an enlarged tax shield which prevails due to the higher tax rate. Another interesting finding, and one that is consistent with Keen and de Mooij (2012) and Gu et al. (2015), is that it is predominantly the better-capitalized banks that have the financial flexibility to increase their debt, while those with less capital only partially increase their short-term debt. Finally, Schandlbauer (2017) finds that these adjustments by better-capitalized banks are only in reaction to income and franchise tax increases, with surcharge tax increases having no significant effect.

Another U.S. focused study is Ashcraft (2008), which highlights the positive cross-sectional relationship between the state tax rate and banks' leverage ratio in the U.S. The paper finds that banks facing higher state income tax rates tend to have more debt in their capital structure.

Evidence points toward a strong bias toward debt funding in corporate finance. Furthermore, no compelling reason has been put forward to explain this tax advantage of debt finance in many countries. This bias not only creates significant inequities but also causes economic distortions. One possible solution is to introduce an allowance for corporate equity. This is one of the main motivations of this paper, as it exploits the introduction of the ACE in Italy in 2012.

The closest work to this current essay is Schepens (2016), which exploits the introduction of the tax shield for equity in Belgium in 2006. In the paper, the author shows that tax shields significantly impacts the capital structure of banks. The author uses a difference-in-differences approach to compare the capital adjustment of Belgian banks that were subject to the tax treatment and a group of matched European banks that did not experience this treatment. The results suggest that, on average, a reduction in the tax bias towards debt relative to equity increases the equity ratio of treated banks. In other words, a more balanced treatment of equity and debt funding increases bank capital ratios, fuelled by movements in common equity. The study further highlights that balancing the debt-equity bias also significantly reduces the level of risk-taking by ex-ante low capitalized banks. Kestens et al. (2012) test whether the notional interest deduction (NID) introduced in Belgium in 2006 impacted the debt ratios of small and medium enterprises. They find significant declines in tax rate and leverage ratios as a result of the reform.

Using German and French firms as controls against 'treated' Belgian firms, Princen (2012) finds a significant negative effect on the financial leverage of a company following the introduction of the 2006 equity tax shield. Panier et al. (2013) confirm these results using a broader and better defined control group. They use firm-level data on Belgium's neighbouring countries as a credible counterfactual. In deciding the control group, they argue that firms in Germany, France, Netherlands and

Luxembourg are geographically close, economically integrated and use the same currency as Belgian firms. As such, they are likely to be exposed to common aggregate shocks. However, these countries did not introduce a reform for equity deductions. The study documents four major findings. First, the introduction of the ACE leads to higher capitalization rates in Belgium. Next, both incumbent and new Belgian firms significantly increase their equity ratios. Third, large firms react more to the new tax incentive, consistent with the notion that smaller firms may face major refinancing cost. Finally, the increase in equity ratios of Belgian firms is explained by a significant increase in the levels of equity and not due to a reduction in the value of non-equity liabilities. Contrary to these findings, Van Campenhout and Van Caneghem (2013) show that NID had no impact on the financial decision making of a group of small firms.

To the best of my knowledge, this essay will be the first to examine the impact of the ACE on banks' capital structure in Italy. Previous studies have focused their attention on non-financial firms. A study by **?** looks at the 2012 ACE in Italy, and its impact on a firm's leverage. They find a negative correlation between the ACE treatment and firms' leverage, with the caveat that this also depends on location, size, and the sector in which the firms operate. The ACE benefit thus allows firms to reduce their tax burden and leverage, and inevitably cut system risk.

Staderini (2001) use company-level data on capital structure to analyse the reaction of Italian firms to the business tax reform of 1997-98. This tax reform, termed the Dual Income Tax (DIT) system, was introduced as a relief for equity finance. It reduced the tax rate on profits with the abolition of the ILOR tax.[5] By reducing the bias against equity capital, this was seen as an initial step to eliminate the bias in capital structure decision. Staderini (2001) find that firms reduce their leverage in reaction to the introduction of the partial ACE. They also look at the composition

[5]The ILOR or Imposta Locale sul Reddito, is a local tax on income in Italy.

of firms that benefited from the reform. The finding highlights that it is mainly the profitable firms and those with high investment rates that benefited and issued new equity, while less profitable companies were not fully incentivised by the improved tax status of equity. However, the authors acknowledge the fact that the paper only considers data up to 1998, and as such, might miss out on delayed effects of the reform. A similar paper by Santoro (2005), with data up to 2000, also finds the expected negative impact of Italy's partial ACE on firms' leverage. More interestingly, he provides two possible arguments for the different reaction of smaller (less-profitable) firms. The first argument, cited in Bordignon et al. (1999), says smaller firms or firms located in the southern regions of Italy were just slower to adjust to the changing tax environment due to short-run asymmetries of information that would not exist in the long-run. The alternative argument is that it is in the nature of smaller firms to favour debt finance since they have a family based property structure which sets upper boundaries to both internal and external equity. Santoro (2005) argues that in this case, even if the Italian partial ACE was not abolished, it would have had the same adverse distributional impact, i.e., smaller firms would never obtain tax reductions, with only the larger firms benefiting. Oropallo and Parisi (2007) show that following the repeal of the tax reform, average tax burden significantly increased.

An assessment of the impact of the ACE and the comprehensive business income tax (CBIT) reveals that both are attractive propositions for European countries. The CBIT, like the ACE, is aimed at mitigating the differential treatment of debt and equity. De Mooij and Devereux (2011) find that if governments adjust statutory corporate tax rates to balance budgets, profit shifting and discrete location make CBIT a more attractive option for most individual European countries. However, in a system of coordination, a joint ACE becomes more efficient than a joint CBIT.

A combination of both improves welfare overall.

Another aspect of the introduction of these tax reforms is how they affect bank lending. While this paper will not directly focus on banks' subsequent lending behaviour, such actions could have implications for regulators and policy makers. Célérier et al. (2017) use loan level data from the German credit register to assess the impact on lending in Germany by banks that were subject to tax reforms in Italy (2000) and Belgium (2006). They find that implementing a tax shield on equity leads to a significant increase in bank lending. The large magnitude of the effect also implies a great degree of sensitivity between bank lending and the cost of equity.

3.3 The Italian ACE system and hypothesis development

The key source of identification in this study is the reform of corporate tax laws in Italy in 2012. Standard corporate income tax systems favour the choice of debt financing over equity financing as interest payments are tax deductible. Moreover, Albert and Expert (2008) highlight that Italian firms are more exposed to debt than other European companies, a claim echoed by Bias (2009) in an IMF study. This excessive debt exposure has been favoured by existing corporate tax laws. By guaranteeing the deductibility of interest on debt, many tax systems encourage debt finance, thus creating under-capitalization and increasing the probability of default risk. This discrimination against equity finance violates the Modigliani Miller theorem.[6] However, in the presence of market imperfections, this adjustment may be slower or even impossible to follow (see for e.g. Almeida et al. (2004)). To reduce

[6] In frictionless capital markets, firms would have the necessary conditions to access the equity market and adjust their capital structure when needed (Modigliani and Miller, 1958)

this tax distortion in favour of debt financing, the Italian government introduced an Allowance for Corporate Equity instrument, to be applied to both financial and non-financial firms. The ACE allows for a notional return on equity, which, like the cost of debt, can be deducted from taxable income, thus contributing to the strengthening of firms' capitalization.

Italy's new ACE system shares some similarities with its previous Dual Income Tax system, which was in force from 1998 to 2003. For example, profit is divided into two components (ordinary and above-normal income) under both regimes. However, whereas ordinary income is taxed at a lower rate under the DIT system, it is completely exempted under the new ACE system.[7] A key feature in both systems is that the ACE benefit is applied only to new equity. De Mooij and Devereux (2011) point out that if the ACE benefits were applied to the whole net internal equity, then its cost would be about 0.5% of GNP. Hence, he proposes a gradual approach aimed at ensuring that ACE benefits only new wealth. Klemm (2007) further explains that the introduction of an ACE narrows the tax base. To account for this potential loss in revenue, the government could increase corporate income taxes. This, he explains, would put the country introducing the ACE at a disadvantage, given a globalized world where capital is internationally mobile. As such, applying the ACE to only new equity would be a more efficient approach. This is the approach that was adopted by the Italian government with the introduction of the ACE tax reform.

3.3.1 Hypothesis development

The role of taxes in determining the capital structure of firms have always been quite significant. The main reason for this is the cost of debt is usually deductible as an

[7] See Bordignon et al. (1999) and Bordignon et al. (2001) for more details on the Italian DIT.

expenditure, while payments to equity holders are not. Introducing an ACE would provide tax relief on the costs associated with using equity to finance investment. The desired effect of the introduction of an ACE is to reduce the debt tax bias, which in turn should lead to better capitalized banks. This is under the assumption that banks will now rely more on internal or external equity and less on leverage. Against this background, the study tests two hypotheses:

Hypothesis 1. The introduction of a tax shield for equity increases bank equity ratios.

The marginal benefit of debt is now reduced, allowing banks to free up resources and rely more on equity.

Hypothesis 2. The allowance for corporate equity will cause banks to reduce their riskiness.

3.4 Data and empirical design

The principal data source for the bank-specific data used in the empirical setup is Bureau van Dijk's Bankscope database. The sample is drawn from all EU-28 countries.[8] See Table A6 for a complete list of the countries selected. I select commercial, savings, cooperative and bank holding companies that have available data for each year from 2008 to 2013 on all the key variables used in the empirical analysis. This period coincides with four years before the introduction of the ACE and two years whilst it was in place. The treatment period is restricted to two years to reduce the possibility of capturing the impact of any other shocks that could affect bank equity ratios.[9] This selection resulted in a sample of 65 Italian banks

[8] I exclude Belgium from the sample given that they were subject to an identical tax treatment in 2006.

[9] Consolidated data is used for most banks. Where this is not available, the aggregated data is used.

and 643 other banks from the European Union.

The main variable of interest is bank equity ratio, which is defined as the ratio of total equity to total assets.[10] Bank-specific controls include: profitability - proxied by return on assets; bank size - defined as the log of total assets; bank risk - defined as the ratio of non-performing loans to total loans, and bank diversification - proxied by the ratio of non-interest income to total income. In order to analyse the underlying drivers of equity ratio changes, the study looks at total loans and banks' retained earnings. As it relates to banks' risk behaviour and stability, I focus on their non-performing loan ratios and Z-score. To capture differences in the level of economic development in each country, the study considers three macroeconomic controls from the World Development Indicators database. These are: GDP per capita, the CPI rate and also the growth rate of GDP.

Table 3.1 provides summary statistics for the main variables used in the analysis. The average equity ratio for the treated and control groups is 16.8% and 14.9% , respectively. The average bank size is almost identical for both groups, with an average of 9.3Mil and 9.4Mil for the treated and control groups, respectively. The average loan ratio is approximately 60% for all banks. The non-performing loans ratio is 10% for all banks. Regarding the macroeconomic controls, the average inflation rate for both groups is approximately 2%, while average GDP per capita stands at about 10.4 million for both groups.

[10] Table A7 provides a description of the variables used throughout the analysis.

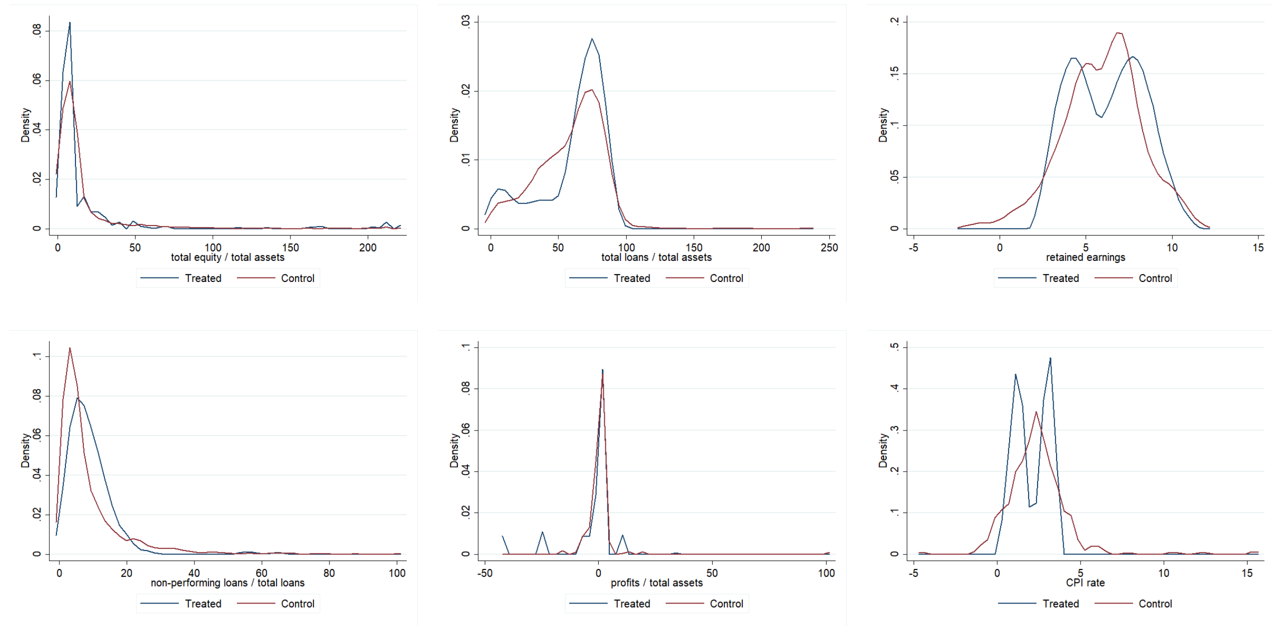
Table 3.1: Summary statistics

Variable		N	Mean	Std. Dev.	Min	Max
Equity ratio	Treated	318	16.860	35.958	0.188	219.950
	Control	3,000	14.923	26.415	0.034	219.950
ln(Total assets)	Treated	318	9.315	2.125	1.695	14.191
	Control	3,000	9.453	2.223	3.847	15.124
Return on assets	Treated	318	0.278	4.891	-42.141	34.219
	Control	3,000	0.188	3.566	-41.411	101.358
Loan ratio	Treated	304	0.609	0.246	0.011	0.947
	Control	2,955	0.585	0.237	0.000	2.337
Non-interest income share	Treated	316	0.454	0.626	-8.500	4.862
	Control	2,982	0.409	0.366	-3.283	6.253
Risk	Treated	263	0.090	0.074	0.000	0.646
	Control	2047	0.082	0.100	0.000	1.000
ln(Z-score)	Treated	312	3.046	0.953	0.133	5.519
	Control	2908	3.054	1.368	-6.373	8.295
ln(Equity)	Treated	318	6.722	1.053	5.048	8.052
	Control	3000	6.729	1.073	5.048	8.052
ln(Retained earnings)	Treated	55	6.245	1.988	3.457	9.918
	Control	2131	5.921	2.285	-2.025	11.765
ln(Loans)	Treated	304	8.602	2.607	-2.768	13.640
	Control	2954	8.747	2.408	-3.640	14.363
Macro controls						
CPI rate	Treated	65	2.111	0.987	0.750	3.375
	Control	643	2.360	1.829	-4.480	15.431
ln(GDP per capita)	Treated	65	10.479	0.032	10.431	10.534
	Control	643	10.414	0.541	8.812	11.582
GDP growth	Treated	65	-1.966	2.400	-5.912	1.374
	Control	643	-0.288	3.135	-14.56	10.281

This table provides summary statistics for the variables which are used throughout the analysis. The treated group refers to banks which experience a change in their tax system, and the control group depicts the banks whose tax system does not change. All variables are defined in Table A7.

Figure 3.1 depicts the kernel density estimates for the treated and control groups and highlights the similarities. The figure highlights the similarities in bank characteristics for both groups. Moreover, Table 3.2 provides further evidence that the treated and control groups display similar characteristics prior to the introduction of the ACE in Italy.

Figure 3.1: Kernel Density Functions



To highlight similarities between treated and control groups, the plots display the main kernel density estimates for the different bank characteristics for the two groups. The treated group refers to banks which experience a tax reform, and the control group depicts the banks whose tax environment does not change.

The parallel trends assumption posits that in the absence of a treatment, on average, the treated and control group should exhibit similar trends in their characteristics over time (Roberts and Whited, 2013). Satisfying this important assumption is key to obtaining reliable difference-in-differences estimates. As such, I examine the growth rates of the main variables used in the estimation in the pre-treatment period. Table 3.2 displays the paired t-test and the Wilcoxon rank-sum test of differences. The bank characteristics of both groups appear to display a common trend prior to the change in the tax environment for Italian banks.[11]

[11] The growth rate of bank size shows a dissimilar trend in both tests, whilst the growth rates of the equity ratio and non-interest income share show a dissimilar trend in the Wilcoxon rank sum test. Further analysis of these variables are carried out in the regression analysis.

Table 3.2: Parallel trend assumption

	t-test	Wilcoxon test
Growth rate of equity/assets	0.10	0.00
Growth rate of ROA	0.76	0.08
Growth rate of NPLs/total loans	0.50	0.07
Growth rate of retained earnings	0.91	0.98
Growth rate of size	0.00	0.00
Growth rate of equity	0.60	0.56
Growth rate of loans/assets	0.73	0.25
Growth rate of non-interest income share	0.39	0.00

This table compares the growth rates of the main bank characteristics between the treated and control group. Growth rates are calculated for the years prior to the introduction of the ACE (2008-2011). The second column provides the p-values of a t-test of differences of the means. The null hypothesis for this test is that the difference in the means of the two groups are not statistically different to zero. The third column shows the p-values of the Wilcoxon rank-sum test. The Wilcoxon test tests the hypothesis that the two independent samples are from populations with the same distribution.

3.4.1 Empirical design

This section describes the methodology used in order to carry out the empirical analysis.

Difference-in-differences methodology

The study employs a difference-in-differences (DiD) estimation approach to examine how a tax reform influences the capital structure of banks. Specifically, the study employs this technique to compare capital structure changes of Italian banks with that of a similar group of European banks that did not experience such a change in their tax environment. The study exploits the introduction of an Allowance for Corporate Equity in Italy in 2012.

The conventional DiD framework consists of identifying a specific intervention or *treatment*. It then requires comparing the difference in outcomes after and before the intervention for groups affected by the intervention to the same difference for unaffected groups. In other words, you test the difference in the difference between the treated group and the control group in the two periods. Therefore, a significant difference in difference would suggest a significant treatment effect. Formally, a standard DiD framework can be described as follows. Let $Y_{i,t}$ be the outcome of interest for individual i by time t (such as a year). The population is observed in a pre-treatment period $t = 0$, and in a post-treatment period $t = 1$. Between these two periods, a fraction of the population is exposed to the treatment. Denote $D_{i,t} = 1$ if individual i has been exposed to the treatment prior to period t, $D_{i,t} = 0$ otherwise. Those individuals with $D_{i,1} = 1$ are known as the *treated*, while those with $D_{i,0} = 0$ are the *untreated* (*controls*).

The conventional DiD estimator is commonly derived using a linear parametric model. A model typically estimated takes the form:

$$Y_{i,t} = \lambda_t + \beta_i + \alpha D_{i,t} + \gamma X_{i,t} + \epsilon_{i,t} \tag{3.1}$$

where λ_t and β_i are time-specific and individual-specific components, α represents the impact of the treatment, $X_{i,t}$ are relevant individual controls, and $\epsilon_{i,t}$ is an error term.

DiD estimations have become an increasingly popular way to estimate causal relationships due to its simplicity as well as its potential to circumvent endogeneity problems that typically exist when making comparisons between heterogeneous individuals (see Meyer (1995) for an overview).

DiD estimation also has its limitations. Bertrand et al. (2004) argues that DiD is appropriate when the interventions are as good as random, conditional on time and group fixed effects. As such, much of the debate around the validity of a DiD estimate usually focuses on the possible endogeneity of the intervention themselves.[12] Another important concern has been whether DiD estimation ever isolates a specific behavioral parameter (see Blundell and MaCurdy (1999) and Heckman (2000)).

In the context of this study, the treated group in the DiD analysis are Italian

[12] See Besley and Case (2000).

banks that were exposed to the tax shield for equity. The control group is represented by other banks in EU that did not experience such a change. Since the ACE was introduced in 2012, the study uses 2012 and 2013 as the treatment period. The treated group consists of 65 Italian banks and there are 643 banks represented in the control group. A specification of the regression model is illustrated by the equation below.

$$ETA_{i,t} = \phi + \lambda_1 * Treated_i + \lambda_2 * Post_t + \lambda_3 * Treated_i * Post_t + \lambda_4 * X_{i,t} + \epsilon_{i,t} \quad (3.2)$$

where

- i represents each bank in the sample;
- t denotes each year in the sample, spanning 2008 to 2013;
- $ETA_{i,t}$ is the equity ratio of bank i in period t;
- $Treated_i$ is a dummy variable that takes the value one for all Italian banks in the sample (treatment indicator);
- $Post_t$ is a dummy taking the value one in the treatment period (2012-2013);
- $X_{i,t}$ contains the previously mentioned bank-specific and macroeconomic controls;[13]
- $\epsilon_{i,t}$ is the error term for bank i at time t

The main variable of interest is the coefficient on the variable λ_3. It will highlight the actual impact of the implemented ACE. Using a difference-in-differences method ensures that the estimates will not be biased by any permanent differences between

[13] All control variables in the vector X are contemporaneous, with the exception of GDP which enters with a one period lag.

the treated and control group. The standard errors are all clustered bank level, unless otherwise stated.

3.5 Results

This section analyses the difference in equity ratios between the treated and control group of banks. Here, the interest is on the impact of the ACE on the capital structure of Italian banks.

Table 3.3: Difference-in-differences regression

	I	II	III	IV
	ETA	ETA	ln(ETA)	ln(ETA)
DiD	5.282	2.668***	0.082**	0.512***
	(4.142)	(0.945)	(0.034)	(0.087)
Post	0.885	-0.635*	-0.018	-0.045**
	(0.756)	(0.382)	(0.011)	(0.021)
Treated	0.006	-	-	-
	(2.915)			
ROA		0.136	0.052***	0.037***
		(0.100)	(0.013)	(0.012)
ln(total assets)		-17.732***	-0.800***	-0.541***
		(2.709)	(0.051)	(0.023)
ln(Risk)		0.079	0.003*	0.004
		(0.076)	(0.002)	(0.003)
Diversification		-0.017**	-0.000	0.002**
		(0.007)	(0.001)	(0.001)
Loan ratio		0.005	0.003**	0.003*
		(0.049)	(0.001)	(0.002)
Retained earnings		0.000***	0.000*	-0.000***
		(0.000)	(0.000)	(0.000)
GDP_{t-1}		11.120*	1.307***	1.058**
		(6.390)	(0.269)	(0.411)
CPI rate		-0.831***	-0.034***	-0.023***
		(0.200)	(0.005)	(0.006)
Constant	14.601***	68.068	-2.389	-4.152
	(1.019)	(69.932)	(2.239)	(4.253)
Observations	2,144	2,144	2,144	2,144
R-squared	0.002	0.330	0.451	0.871
Country FE	No	-	-	Yes
Bank FE	No	Yes	Yes	-
Cluster level	Bank	Bank	Bank	Country

This table analyzes the impact of the change in tax regulation in a difference-in-differences setup. The sample period is 2008 - 2013. The first column shows the regression of the equity ratio (ETA) on a post-event dummy that equals one in 2012 - 2013 (Post), a dummy indicating whether the bank is an Italian bank (Treated) and an interaction term (DiD) between both dummies that captures the actual impact of the tax change. In the first column, the model is estimated using OLS. In the second column, bank fixed effects are added, which make the Treated dummy obsolete, as it does not change within a bank. In the third column, the dependent variable is the natural logarithm of the equity ratio. Column 4 is similar to Column 3, but standard errors are clustered at the country level instead of at the bank level. ***, ** and * denote $p < 0.01$, $p < 0.05$ and $p < 0.1$ respectively.

Table 3.3 reports the results obtained from the difference-in-differences estimation of (3.2). The models include country and bank fixed effects. Clustering of standard errors are at bank level, unless otherwise stated. The first column of Table 3.3 reports a specification with no country or bank fixed effects. Furthermore, it excludes all the bank specific and macro controls, and simply regresses the equity ratio on the Post, Treated, and interaction dummies. The coefficient on the variable of interest (DiD), which captures the impact of the introduction of the tax shield, is positive but statistically insignificant in this case.

In the next setup, I add a set of bank and country-specific controls to the regression. Specifically, I add proxies for bank profitability (ROA), bank size (natural log of total assets), bank diversification, risk (ratio of non-performing loans to total loans), asset structure (loan ratio), retained earnings, CPI rate, and the log of GDP. The interaction variable (DiD) now carries a positive and significant coefficient of 2.668. This indicates that, on average, equity ratios for Italian banks increased following the implementation of the tax shield on equity. The results in column III indicate this corresponds with an increase of 8.5% for the average bank in the sample.[14] This finding is largely in-line with previous studies. Schepens (2016) shows that such a reduction in the tax discrimination leads to a significant improvement in the capitalisation of banks. He shows that, following the introduction of an ACE in 2006, Belgian banks increased their equity ratios by approximately 13%. Panier et al. (2013) document that non-financial firms have become better capitalized in response to the reduction in the tax bias towards debt. Similarly, Panteghini et al.

[14]The correct interpretation of a log-linear equation with a binary dependent variable is derived by Kennedy et al. (1981). He derives it as: $g^* = exp[\hat{c} - 1/2\hat{V}(\hat{c})] - 1$, where g^* is the percentage change in the dependent variable given a change in the dummy variable from zero to one, $\hat{c}$ is the estimated coefficient on the dummy variable, and $\hat{V}(\hat{c})$ is the estimated variance for this coefficient. This transformed coefficient is used throughout the paper.

(2012) show that, for non-financial firms, the implementation of the ACE reform in Italy reduces but does not completely eliminate the financial distortion due to interest dedcutibility. They show that despite the permanence of a tax advantage toward debt, the ACE relief is estimated to significantly reduce leverage. Klemm (2007) finds slightly contrasting results when studying an ACE system in Brazil. He finds that, despite the reduction in the tax preference for debt finance, there was no significant change in capital structures. Instead, it led to higher dividends and an increase in debt-equity ratios. However, this might be attributed to peculiarities within Brazil's corporate tax system. In column IV, the standard errors are now clustered at country level. This is done because the treatment varies at the country level. The result is broadly consistent with the findings in the previous columns.

Overall, the results in Table 3.3 indicate that the tax policy reform brought about the desired effect. That is, the introduction of the ACE that reduces the tax bias between debt and equity, has a significantly large impact on banks' capital structure. Italian banks markedly increased their capital following the treatment, relative to what would be expected without the ACE.

Table 3.4: Equity ratio components

	I	II	III	IV	V
	ln(ETA)	ln(Equity)	ln(Total assets)	ln(Loans)	ln(Retained earnings)
DiD	0.082**	0.082**	0.037	0.076	-0.565
	(0.034)	(0.034)	(0.066)	(0.058)	(0.354)
Post	-0.018	-0.018	0.043***	0.026	0.117***
	(0.011)	(0.011)	(0.015)	(0.019)	(0.035)
Constant	-2.389	-6.994***	2.969	-1.877	-16.544**
	(2.239)	(2.239)	(2.255)	(3.327)	(8.299)
Observations	2,144	2,144	2,144	2,144	1,823
R-squared	0.451	0.232	0.161	0.318	0.081
Bank FE	Yes	Yes	Yes	Yes	Yes
Cluster level	Bank	Bank	Bank	Bank	Bank

This table analyses the underlying drivers of the equity ratio after the introduction of the notional interest rate deduction. The sample period is 2008 to 2013. The Post dummy equals one in 2012 to 2013, the Treated dummy equals one for the Italian banks. The first column retakes the baseline result from Table 2 . Columns 2 and 5 analyse the impact on equity and one of its sub-components, while Columns 3 and 4 look at the impact on the asset side. All left hand side variables are in natural logarithms. Retained income share is the ratio of retained income over after-tax profits. All regressions include bank-fixed effects, standard errors are clustered at the bank level. ***, ** and * denote $p < 0.01$, $p < 0.05$ and $p < 0.1$, respectively.

The next step is to identify whether the observed change in equity ratios are being driven by the ACE, which reduces the tax bias, or by a decrease in bank assets. This is done by examining the components of the equity ratio.

Table 3.4 provides the findings on the drivers of the equity ratio. The first column merely repeats the main finding of Table 3.3, which shows that average equity ratios for Italian banks increased by approximately 8.5% after the introduction of the ACE. In column II, the equity ratio is replaced by the natural log of equity as the dependent variable. The positive and significant coefficient indicates that the change in equity ratios is indeed being driven by an increase in equity. Furthermore, this finding is consolidated by examining the change in bank assets and loans, in columns III and IV. The results reveal that there is no significant difference in the evolution of total assets and loans between Italian banks and other European banks from the control group. In other words, there is no evidence to suggest that there was a reduction in bank activities following the implementation of the ACE in 2012. In column V, I attempt to identify whether banks are using their retained earnings to build this capital buffer. However, the study finds no significant evidence of this. Overall, the findings reported in this table show that the increase in equity ratios, following the reduction in the tax bias, is being driven by an increase in bank equity, rather than a decline in bank activities. Furthermore, there is no evidence of an increase in retained earnings, which could potentially contribute to the building of this capital buffer. However, other non-retained earnings factors (e.g. shareholder capital and other reserves) could be fuelling this increase. The data set used in the study did not allow for further breakdowns to capture the impact of these variables. Nonetheless, the key finding of increases in equity rather than decline in assets limits the scope for any negative externalities to bank activities. That is, it minimizes the incentive to significantly reduce lending during downturns or to increase lending during credit booms.

The analysis so far points to significant increases in bank equity ratios following the implementation of the ACE. Yet, regulators might be interested to know whether different types of banks react in a similar manner to this policy reform. Schepens (2016) argues that if it were only the highly capitalized banks that react to this policy change, then regulators might view the policy as less appealing compared to a situation in which ex ante low capitalized banks are also impacted. As such, Table 3.5 attempts to analyze the difference in behaviour of ex ante high and low capitalized banks in reaction to the reduction in the tax bias. For this analysis, I classify high capitalized banks as those with equity ratios that fall in the upper quartile, and low capitalized banks as those that fall in the first and second quartile, of the size distribution.

I also examine the ex ante risk taking behaviour of these banks in Table 3.5.

There is an extensive literature on the relationship between capital and risk taking. In theory, an unregulated bank will take excessive portfolio and leverage risks in order to maximize its shareholder value at the expense of the deposit insurance (see Benston (1986); Furlong and Keeley (1989); Keeley and Furlong (1990)). These moral hazard incentives can be reduced by capital requirements if shareholders are forced to absorb a substantial portion of the losses, thereby decreasing the value of the deposit insurance put option. If the level of risk-taking is minimised, coupled with higher capital levels, then it is expected that there will be lower probability of default. However, the view that capital requirements reduce risks, thereby strengthening banking system resilience has been challenged in many quarters. Koehn and Santomero (1980), Kim and Santomero (1988) and Rochet (1992) find that the bank's expected return will be diminished by a forced reduction in leverage if capital is relatively expensive. Consequently, the owners of the bank may opt for a higher point on the efficiency frontier, which is associated with greater returns and more risk. The increase in the level of riskiness by the bank overcompensates the increase in capital and translates to a greater probability of default.

Table 3.5 presents the findings on these relationships. The first column indicates that low capitalized banks increase their equity ratio following the reduction in the tax bias. The coefficient on the interaction term suggests that average equity ratios are approximately 12.2% higher for Italian banks, compared to those in the control group. Similarly, highly capitalized banks increase their equity ratio by approximately 7.6% (see column 2) in response to the tax treatment. These results indicate a degree of homogeneity across banks' response and might satisfy regulators as to the effectiveness of the policy.

Table 3.5: Heterogeneity in the treatment effect and bank risk behaviour

	Low-capital banks	High-capital banks	Low-capital banks	High-capital banks
	ln(ETA)	ln(ETA)	ln(Risk)	ln(Risk)
DiD	0.116***	0.073**	-0.152*	0.756*
	(0.040)	(0.033)	(0.089)	(0.434)
Post	-0.036**	-0.010	0.335***	0.149
	(0.017)	(0.017)	(0.041)	(0.100)
Constant	-1.263	4.238	66.355***	28.416*
	(3.217)	(2.955)	(7.985)	(14.558)
Observations	1,369	503	1,243	420
R-squared	0.445	0.756	0.356	0.194
Bank FE	Yes	Yes	Yes	Yes
Cluster level	Bank	Bank	Bank	Bank

This table illustrates the difference in the impact of the ACE on high and low capitalised banks. The sample period is again 2008 to 2013. The Post dummy equals one in 2012 to 2013, the Treated dummy takes the value of one for the Italian banks. The first two columns show the the impact of the ACE on (ex-ante) high and low capitalised banks. I classify high capitalised banks as those whose equity ratio fall in the fourth quartile of the size distribution, and low capitalised banks as those that fall in the first and second quartile of the size distribution. The sample for the highly capitalised banks now comprises of 12 treated banks and 132 untreated banks. For the low capitalised sample, there are 36 treated banks and 254 untreated banks. In the third and fourth column, I examine the ex ante risk-taking behaviour of these high and low capitalised banks. I use the ratio of non-performing loans to total loans as the left hand side variable. All regressions include bank fixed effects, standard errors are clustered at the level. ***, **, and * denote the $p < 0.01$, $p < 0.05$ and $p < 0.1$, respectively.

Next, the study turns attention to bank risk-taking behaviour in columns III and IV, where the dependent variable is the ratio of non-performing loans to total loans. The negative coefficient on the interaction term, in column III, suggests that banks with relatively lower capital levels tend to reduce their level of risk-taking. On the other hand, the results differ for highly capitalized banks. The positive coefficient on the variable of interest, in column IV, points to higher levels of risk-taking by these banks, following the reduction in the tax bias. This heterogeneous finding in bank risk-taking behaviour is not unexpected. Shrieves and Dahl (1992) posit that the relationship between risk and capital in banks is not strictly the result of regulatory influence. They argue that it rather reflects the view that risk-taking behaviour tends to be constrained by bank owners' or managers' private incentives. They find that this is consistent with the leverage and risk-related cost avoidance and managerial risk aversion theories of capital structure and risk-taking behaviour in commercial banks.

Overall, the results in Table 3.5 indicate that both high and low capitalized banks increase their equity ratios after the implementation of the tax shield for equity. However, only low capitalized banks decrease their riskiness after the implementation of the ACE. High capitalized banks instead increase their levels of riskiness. This finding is similar to that of Schepens (2016), who argues that a potential explanation for this behaviour by high capitalized banks is that there are diminishing returns to the screening and monitoring of borrowers. This view is in line with the work of Besanko and Kanatas (1993) and Carletti (2004) on convex cost functions of bank monitoring, which argues that it is increasingly difficult for a bank to discover more and more about a firm.

3.5.1 Robustness

To gauge the reliability of the results, a series of robustness checks are carried out. The first is to ensure that the results do not suffer from a sample selection bias. Estimations are done to see whether the results are being driven by outliers. In addition, a placebo test is performed to confirm that the results do not hold under a false treatment date. A placebo test is also done using one of the control group countries as the country that received treatment.[15] The results from these additional tests will serve to buttress the main findings.

The results of the above-mentioned robustness checks are presented in Table 3.6. The first column tests whether the main findings are being driven by sample selection. To do this, the number of countries from which the control group of banks are selected is restricted to a set of countries with a similar macroeconomic environment.

[15] For completeness, this exercise is repeated using each of the remaining control group banks, in turn. The results are presented in Table A9.

Specifically, the study uses the remaining members of the so called GIIPS countries (Greece, Ireland, Portugal and Spain). This group of countries experienced similar economic climate before and after the crisis. The GIIPS countries were among the European countries most severely affected by the global financial crisis. All five countries experienced similar banking sector problems, credit crunches, and government debt crises. Similarly, in the decade prior to the crisis, all five countries experienced rapid economic growth, stable inflation and rapidly growing domestic credit. As such, limiting the control group to these set of countries helps to control better for the common macroeconomic factors in the treated and the control group. The result of this test is shown in the first column. The coefficient on the interaction term remains positive and significant. The finding suggests that the introduction of the ACE, on average, increases the equity ratios of Italian banks by approximately 11%.

Table 3.6: Robustness checks

	Control countries (GIPS)	Outliers	Outliers	Placebo (year)	Placebo (Spain)
	ln(ETA)	ln(ETA)	ln(ETA)	ln(ETA)	ln(ETA)
DiD	0.106*	0.074**	0.079**	-0.025	-0.057
	(0.060)	(0.032)	(0.035)	(0.022)	(0.084)
Post	-0.059	-0.018	-0.015	0.059***	-0.015
	(0.059)	(0.011)	(0.011)	(0.016)	(0.012)
Constant	-5.986	-2.401	-3.300	-5.182*	-2.040
	(5.961)	(2.239)	(2.281)	(3.133)	(2.428)
Observations	560	2,143	2,104	1,543	2,113
R-squared	0.357	0.451	0.437	0.454	0.451
Bank FE	Yes	Yes	Yes	Yes	Yes
Cluster level	Bank	Bank	Bank	Bank	Bank

This table provides five robustness checks for the difference-in-differences results. For each robustness check, the dependent variable is the natural logarithm of the equity ratio. All the regressions include the same set of control variables as used in the main setup in Table 2, column 3. Standard errors are again clustered at the bank level. The sample period is once again 2008 to 2013. For the first robustness check, in column 1, I restrict the countries from which the control group of banks are selected to four countries (Greece, Ireland, Portugal and Spain) with similar macroeconomic environment. In the second column, I remove the 10% of Italian banks that had the highest growth in equity ratios after the introduction of the ACE. In the third column, I then remove the 10% of control group banks that had the lowest growth in equity ratios after the the introduction of the ACE. In column 4, I perform a placebo test where I assume the treatment took place in 2010 instead of 2012. In the final column, I perform another placebo test where I assume the ACE was introduced in Spain instead of Italy. ***, **, and * denote $p < 0.01$, $p < 0.05$ and $p < 0.1$, respectively.

The second and third columns of Table 3.6 test whether the main results are being driven by extreme outliers. In the first instance, the 10% of Italian banks that had the highest growth in equity ratios after the implementation of the ACE are removed. In doing so, the idea that the overall growth in equity ratios is being driven by only a few Italian banks can be dismissed. The 10% of control group banks that had the lowest growth in equity ratios following the introduction of the ACE were then removed. The results for these two scenarios are shown in columns II and III, respectively. The coefficients on the difference-in-differences variable in both columns are consistent with the main results.

In the next column of Table 3.6, a placebo test is performed under the assumption that the ACE was introduced in 2010 instead of 2012. Under this assumption, the treatment effect should not be significantly different from zero. If it is, this would suggest that the difference-in-differences strategy might be picking up other unobservable differences between the treated and control group. In such an event, estimations of the impact of the implementation of the ACE on equity ratios would be biased. However, the result of this test, as shown in column IV, dismisses this possibility. This test finds no significant evidence to suggest that banks increase their equity ratio following the false treatment. The final column of Table 3.6 presents another placebo test, this time assuming that the country that received the treatment is Spain instead of Italy.[16] Again, this returns no significant evidence that would suggest that these banks increase their equity ratios. These findings validate the setup of the difference-in-differences model used.

Finally, I check whether the results of Table 3.5 are robust to alternative classifications of low and high capital banks using country-based indicators. The results of these tests are presented in Table A8 of the appendix. In this setup, high capitalised banks are those whose equity ratio fall in the highest decile of the size distribution within each country. Low capitalised banks are those that fall in the bottom 30 percentile of the size distribution within each country. The results presented using this alternative classification are largely in line with the findings in Table 3.5. This therefore serves to buttress the evidence that both ex-ante high and low capital banks increase their capital because of the ACE, whilst low capitalised banks tend to reduce their level of riskiness following this tax reform.

3.6 Conclusion

In the wake of the recent financial crisis, the debate surrounding bank capital regulation has come under increasing attention. Indeed, capital requirements have become one of the key instruments of modern day banking regulation, providing both a cushion during adverse economic conditions and a mechanism for preventing

[16]For this estimation, Italy is removed from the sample in order to avoid any offsetting effect.

excessive risk taking ex ante. Nonetheless, the discussion surrounding bank capital regulation quite often ignores the tax deductibility of interest expenses on debt. A tax-induced debt bias may contribute to the heavy reliance on debt finance - which has the potential to severely impair macroeconomic stability and growth. As such, this paper explores a potential avenue to level the playing field in debt versus equity finance, by documenting the impact of a tax shield on bank capital structure. The study exploits the exogenous variation in the tax treatment of debt and equity due to the implementation of an allowance for corporate equity instrument in Italy.

The ACE is anticipated to reduce the relative tax advantage of debt and thus encourage bank capitalization. Using a difference-in-differences approach this essay compares the change in capital structure of Italian banks with that of a similar group of European banks that did not experience a similar change in their corporate tax system. The results suggest that, following the introduction of the ACE, the equity ratio of the average Italian bank increases by approximately 8.5%. Since the ACE is a tax shield for equity, equity funding becomes more attractive and banks increase their equity ratio. It is important to highlight that the ACE does not increase banks' equity ratios by merely reducing lending activities, which would have a negative spin off effect on the real sector. Indeed, the results provide evidence that the increase in equity ratios is being driven by an increase in bank equity rather than a reduction in any loan activity by banks. Additionally, the study finds that this tax relief for equity reduces risk taking for weakly capitalized banks.

Overall, this essay contributes to the debate on bank capital regulation, corporate tax policy and financial regulation by investigating the effects of an ACE on banks' capital structure. The study highlights the important role that an ACE instrument can play in macroprudential regulation. While it is generally acknowledged that the implementation of an ACE system can be challenging, it can bring about great advances in the economy. The prevailing debt bias of taxation distorts regulatory efforts made to reduce leverage. On the other hand, ACE systems support capital regulations in their pursuit of a well-functioning stable financial system.

Therefore, this study strongly recommends that an ACE system, that eliminates or significantly reduces the tax-induced distortions in banks, should be on the agenda of macroprudential policymakers. The reduction in the tax discrimination not only leads to better capitalized banks, but it also decreases the risk-taking behaviour for weakly capitalized banks, who are usually targeted by regulators. Furthermore, a reform that is centred around the debt tax bias might have positive externalities, since a better legal and regulatory system is positively associated with financial development and economic growth (Levine, 1999).

Chapter 4

The Impact of liquidity Holdings on Bank Profitability

4.1 Introduction

How does liquidity affect bank profitability? The recent global financial crisis prompted the Basel Committee on Banking Supervision (BCBS) to strengthen its liquidity framework. They began this process by developing two minimum standards for liquidity funding. The objective of these standards are to promote short- and long-term resilience of banks' liquidity risk profile and to create incentives for banks to fund their activities with more stable sources of funding on an ongoing basis.[1] An unintended consequence of this regulatory reform is the subsequent cost it may impose on banks in terms of reduced profitability from holding these lower-yielding assets.

Highly liquid assets such as cash and government bonds tend to have relatively low return, hence holding them imposes an opportunity cost on banks. It is therefore reasonable to expect that banks will only hold these assets to the extent where they contribute to maximizing profits. Beyond this, regulators may still require banks to hold further liquid assets if it will enhance the ability of the banking sector to absorb liquidity shocks arising from economic and financial stress. Against this background, the aim of this essay is to test empirically whether banks' holding of liquid assets significantly affect their profits. The results of such an investigation will have important implications for the implementation of regulatory policies aimed at mitigating liquidity risks and the calibration of policy tools to account for the associated costs at the bank level.

The study also explores the cyclical behaviour of bank profits. Knowledge of the link between cyclical fluctuations and banking sector profitability is crucial in evaluating the stability and soundness of the financial system. Unfavourable eco-

[1] The committee introduced the liquidity coverage ratio (LCR) to ensure that banks hold sufficient high quality liquid assets to withstand acute stress scenarios lasting one month. The net stable funding ratio (NSFR) was introduced to increase incentives for banks to fund themselves using more stable sources on a structural basis.

nomic conditions have the potential to worsen the quality of loans and generate credit losses, which in turn reduces bank profits. Depending on their level of capitalization, the ability of banks to sustain the activity of the private sector may also be jeopardized, and the fluctuations of the business cycle may be exacerbated (Gambacorta and Mistrulli, 2004). Whilst the impact of the business cycle on profitability has been heavily explored in the empirical literature, until now, the role of the financial cycle has been largely ignored. Given how closely domestic credit growth usually mirrors global credit growth, it becomes important to understand whether policies geared toward moderating credit growth could have a significant impact on bank profitability. To some extent, the task of detecting any relationship between the financial cycle and bank profitability is made difficult by the fact that there is no "natural" financial cycle measure established in the literature. Following Stremmel (2015), Drehmann et al. (2012), and Claessens et al. (2011), this essay uses credit aggregates (credit-to-GDP ratio and credit growth) and asset prices (property prices) as the key measures to capture the best fitted financial cycle.

To answer the key questions of how does liquidity affects profitability and what are the relative roles of the business and financial cycles in explaining variations in bank profits, the study exploits bank-level data of 843 banks from 33 advanced and emerging market economies over the period 2005–2017. The results emerging from this analysis provide some key insights that may be relevant for bank regulators and policymakers alike. The first key result emerging from this study points toward a non-linear relationship between liquidity and bank profitability. That is, profitability improves for banks that hold some liquid assets, however, there is a point where holding further liquid assets reduces profitability. Second, bank profitability responds positively to measures of the financial cycle, while there is no evidence to suggest that the business cycle has any significant impact on profitability.

In the context of the ongoing regulatory reform of the Basel liquidity framework and knowledge of the fact that the financial sector plays a major role in shaping macroeconomic outcomes, these findings provide useful evidence that should be considered in order to ensure that the financial system as a whole remains sound and stable.

This essay makes important contributions to the literature. It focuses on a potential determinant of bank profitability that has largely been overlooked. The few studies that include liquidity as an explananorty variable for bank profits hardly focus on this specific relationship. However, given the BCBS move to develop new standards aimed at reducing liquidity risk, it becomes important to study whether banks' decision to hold liquid assets significantly impact on their profitability. Bordeleau and Graham (2010) explore this particular relationship for U.S. and Canadian banks. This study builds on Bordeleau and Graham (2010) in three ways. First, it extends the sample to include emerging market economies (EMEs). The economic environment in which EMEs operate may differ substantially from those in advanced economies, therefore it is important to identify whether this relationship is homogeneous across banks irrespective of the development status of the country in which they operate. Second, this paper also extends the work of Bordeleau and Graham (2010) by assessing the role of the financial cycle in explaining changes in bank profits. The literature surrounding the cyclical behaviour of bank profitability solely focuses on the business cycle. By exploring the role the financial cycle, this study has the potential to inform regulators about the design of policy tools geared toward smoothing cycles. That is, if the financial cycle turns out to be a better predictor of profitability than the business cycle, then policies aimed at reducing the amplitude of the financial cycle would have the added effect of smoothing the cyclical behaviour of bank profitability. Finally, this study uses an econometric approach that accounts for the persistence of profits. Bordeleau and Graham (2010) use a static model to carry out their experiment. However, since the profitability indicators used in this study displays persistence and the control variables could suffer from endogeneity, this paper employs a dynamic GMM approach.

The remainder of the essay is organized as follows. Section 4.2 discusses the existing literature on why banks hold liquid assets, the determinants of bank profitability and the relationship between the cycle and profitability. Section 4.3 describes the data and methodology used in constructing the various cycles. The empirical design used to carry out the estimation is presented in section 4.5. Section 4.6 discusses the empirical results, and section 4.7 presents the conclusions.

4.2 Literature overview

While there is a large tranche of literature that analyses the liquidity holdings for firms (this is briefly reviewed in section 4.2.1), the literature on why banks, in particular, hold liquid assets is scant. Nonetheless, related literature on bank liquidity risk indirectly provide evidence on the main reasons behind this decision for these financial intermediaries.

Banks need to hold and maintain a buffer of liquid assets in order to avoid liquidity risks. According to Supervision (1997), liquidity risk is the risk that arises from the inability of a bank to accommodate decreases in liabilities or to fund increases in assets. The study further explains that when a bank has inadequate liquidity, it cannot obtain sufficient funds, either by increasing liabilities or by converting assets promptly, at a reasonable cost, thereby affecting profitability. Liquidity risks can take numerous forms but for banks it is primarily the risk of having a large number of depositors and investors demanding a withdrawal of their savings all at once, leaving the bank short of funds. If banks default, that is, being in a situation where they are unable to repay depositors whatever they are owed when these debts fall due, they become 'cash-flow insolvent'. It is predominantly for this reason why banks hold a certain amount of liquid assets and why regulators (e.g. Basel Committee) continuously try to develop and strengthen standards aimed at minimising liquidity risks. Regulators are even more concerned because of the possible spillover effects and the implications it might have for the banking system as a whole. For example, the failure of one bank can have spillover effects if it causes depositors and investors to assume that other banks will fail as well (Farag et al., 2013). This is due to the fact that other banks may hold similar loan portfolios, which might also fail or be written off, or even because they might have provided loans to the bank that has failed.

Liquidity risk can be divided into two categories; *funding liquidity risk* and *market liquidity risk*. Funding liquidity risk refers to a situation where a bank does not have enough cash or collateral in order to meet payment obligations with customers and other counterparties as they fall due. However, market liquidity risk is the risk that banks are unable to easily unwind or offset specific exposures without significantly lowering market prices because of inadeqaute market depth or market disruptions (see Decker (2000) and Farag et al. (2013)). Farag et al. (2013) argue that market liquidity risk is mainly a function of the market for an asset and not necessarily the circumstances of an individual bank. Due to its nature, a market liquidity risk can result in a particular bank eventually facing a funding liquidity crisis.

Farag et al. (2013) propose two ways to mitigate both of these liquidity risks. First, they suggest that banks can attempt to attract more stable funding sources that are less susceptible to bank runs. The second way to mitigate these risks is for banks to maintain a buffer of highly liquid assets that can easily be drawn down when liabilities fall due. They argue that this liquidity buffer becomes crucial if a bank is not able to restore its existing funding sources or if other assets are not easy to liquidate. This buffer of highly liquid assets would mitigate both types of liquidity risk.

As mentioned before, these liquidity requirements which are designed to prevent and mitigate liquidity risks are implemented by the BCBS. Hugonnier and Morellec (2017) show that when faced by these requirements, banks voluntarily choose to hold reserves in excess of the required minimum in order to avoid the costs associated with breaches of the requirement. Further, Stolz and Wedow (2011) argue that liquid assets have on average a non-zero risk-weight. Therefore, banks can increase their capital buffer by liquidating these assets and, thus, banks with more liquid assets have a lower optimum capital buffer.

4.2.1 *Reasons why firms and intermediaries hold liquid assets*

This subsection of the literature review briefly gives an overview of the reasons firms hold liquid assets. The motives discussed also relate to some of the underlying principles regarding banks decision to hold highly liquid assets.

Early studies on liquidity holdings are framed around the benefits of holding cash. The finance and economics literature highlight the transaction, precaution, agency motive, and the tax motive as the four key reasons why firms and financial intermediaries hold liquid assets. This section reviews these four motives and other potential factors affecting firms' decision to hold liquid assets.

The transaction motive. Early academic research by the likes of Baumol (1952), Meltzer (1963), Tobin (1956), and Miller and Orr (1966) develop arguments based on trade-offs motivated by transactions costs. These arguments suggest that firms hold cash to avoid the cost associated with being low on liquid assets. Much like their non-financial counterparts, banks also hold cash and other liquid assets to avoid the punishment associated with falling below the Basel minimum requirement. Furthermore, Farag et al. (2013) argue that banks that do not maintain a good level of liquid assets might end up having to do 'fire sales' or overpay or additional funds in order to meet thier financial obligations. Miller and Orr (1966) derive what they deem the optimal demand for cash when a firm incurs transaction costs associated with the conversion of a non-cash financial asset into cash and uses cash for payments. Put differently, firms benefit from holding liquid assets by saving transaction costs to raise funds and avoid having to liquidate assets to make payments. Mulligan (1997) finds evidence suggesting that there are economies of scale associated with the transaction motive, as such larger firms tend to hold less cash.

The precaution motive. Firms can use liquid assets to finance operations and investments if other sources of funding are scarce or excessively costly. Consistent with this standpoint, Opler et al. (1999) find that firms with riskier cash flows and limited access to external capital hold more liquid assets. Their findings also suggest that firms with better investment opportunities hold more cash because adverse shocks to the economy and to the financial system are more costly for them. Almeida et al. (2004) show that financially constrained firms increase cash holdings when cash flow is high, or in other words, constrained firms invest in cash out of cash flow, while unconstrained firms do not. A later study by Han and Qiu (2007) corroborates this finding. Using a theoretical framework which allows for a continuous distribution of cash flow, they demonstrate that an increase in the volatility of cash flow increases cash holdings for firms that are financially constrained, but has no determinate effect on other firms. Riddick and Whited (2009) however, challenge the findings on firms' propensities to invest in cash out of cash flow pointing out that the literature does not adjust for measurement error in q. Nonetheless, their model shows that a firm's risk and its level of cash are positively related. Finally, Acharya et al. (2007) develop a model showing that firms accumulate cash instead of reducing debt when the correlation between operating income and investment opportunities is low. Other contributing studies to the precautionary motive for holding cash include Bates et al. (2009) and Dittmar et al. (2003).[2]

The agency motive. The free cash flow theory of Jensen (1986) suggests that managers would rather retain cash than to increase payouts to shareholders when the firm has poor investment opportunities. For managers, cash reduces the pressure to perform well and allows for investment in projects that best suit their own interests, but not necessarily inline with the interest of shareholders. These discretionary cash holdings are usually estimated as the excess liquidity holdings derived from models accounting for the precautionary and transaction motives for holding cash. Dittmar et al. (2003) find evidence which suggests that agency costs play an important role in determining firms' cash holdings. In a cross country setup of over 11,000 firms, they find that corporations in countries with low protection of shareholders rights hold up to twice as much cash as their counterparts in countries with strong shareholder protection. This evidence is consistent with the perspective that investors in countries with weak shareholder protection cannot force managers to disgorge excessive cash balances. Guney et al. (2003) find similar results for firms in France, Germany, Japan and the United Kingdom. Using data for nearly 4,000 firms over the period 1983-2000, they find that a country's legal structure and the ownership structure of firms play a crucial role in determining cash holdings. Specifically, they identify that a higher degree of shareholder protection is associated with lower cash holdings and ownership concentration exerts a negative impact on cash levels. Dittmar and Mahrt-Smith (2007) show that cash is worth less when agency

[2] As this is not the focus of this current essay, these will not be extensively reviewed.

problems between insiders and outside shareholders are greater.

The tax motive. Finally, the tax motive for holding cash appears far less researched than the preceding three. Foley et al. (2007) examine whether the tax costs associated with repatriations contribute to the desired level of cash holdings. Using a large sample of firms drawn from Compustat over the period 1982-2004, they document four key results. First, they find firms are subject to higher tax when repatriating earnings tend to hold more cash. A one standard deviation increase in the tax costs associated with repatriations result in the ratio of cash to net assets increasing by approximately 8%. Second, the tax costs associated with repatriations induce firms to hold more cash abroad. The third finding suggests that affiliates who are faced with higher tax when repatriating earnings hold more cash than other affiliates of the same firm. This particular finding indicates that incorporated affiliates in lower tax jurisdictions have higher cash holdings, whereas affiliates that are organized as branches hold lower levels of cash that do not vary with host country tax rates. Finally, the authors find that firms that are financially constrained domestically are less likely to defer taxes associated with repatriations by holding cash abroad. For these firms, affiliate cash holdings are low and are not related to the host country's tax rates. However, firms that rely heavily on technology seem to have affiliate cash holdings that are very responsive to the tax costs triggered by repatriations.

4.2.2 *Liquidity and profitability*

As shown in the previous sections, there is a broad body of literature looking at the analysis of liquidity asset holdings for firms, and to a lesser extent for banks. Nevertheless, its role as a determinant of bank profitability has hardly been explored. Most studies looking at the determinant of bank profitability do not include liquidity as an explanatory variable, while the few that include it do not focus on this particular relationship. A notable exception to this is Bordeleau and Graham (2010) who examine the impact that a change in bank's liquid asset holdings has on profitability for US and Canadian bank holding companies. Using a panel two-step Generalised Method of Moments (GMM) approach, they regress bank profitability against a non-linear expression of relative liquid asset holdings, after controlling for other bank and country specific determinants. Their findings suggest that banks are rewarded profitably for holding some liquid assets, but at some point, these low-yielding assets have a negative impact on profit because of the forgone opportunity to invest in riskier assets. The results further suggest that GDP has a positive impact on banks' profitability, while the level of unemployment and inflation negatively impacts profitability, owing to higher probability of default on loans and the role of maturity transformation, respectively.

This essay seeks to build on the findings of Bordeleau and Graham (2010) and to make a novel contribution to the literature by examining the potential role of the credit cycle in determining banks' profitability. Further, the study will look at the impact of lending rates and assess whether short and long-term interest rates have differing impact on banks' profitability. Finally, the literature on the determinants of bank profitability predominantly focuses on advanced economies (see for e.g. Albertazzi and Gambacorta (2009), Bolt et al. (2012), and Dietrich and Wanzenried (2011)), this study will also draw on banks from a number of EMEs as the economic environment in which they operate may differ substantially from those in advanced economies.

The section of the literature that includes liquidity as a determinant of profitability is quite small and provides mixed results. Molyneux and Thornton (1992) find a weak negative relationship between profitability and liquidity holdings, arguing that this is expected due to the fact that liquidity holdings imposed by authorities represent a cost to the bank. In contrast, Bourke (1989) and Tan (2016) find that liquidity positively impacts bank profitability. Despite the lack of sufficient research into this relationship, reasonable comparisons can be drawn from related literature surrounding the impact of capital on bank profitability.

Using Granger-causality analysis, Berger (1995) cites a strong positive relationship between capital and earnings (ROE), suggesting that well capitalised firms face lower expected bankruptcy costs. This in turn reduces their funding cost and increases their profitability. Though this particular finding contrasts the well known works of Modigliani and Miller (1958) and Modigliani and Miller (1963) on perfect capital markets with symmetric information, the author argues that the results are consistent with the "*expected bankruptcy cost hypothesis*." In a similar study, Lee and Hsieh (2013) use bank-level data for 42 Asian banks to test the relationship between capital and profitability. They find similar results to Berger (1995), with capital exhibiting a positive and significant effect on profitability. However, Lee and Hsieh (2013) attribute their finding to the "*structure-conduct-performance hypothesis*." A positive relationship between capital-assets ratio and profitability is also found in Goddard et al. (2004). While Berger (1995) attributes his finding on the capital-profit relaionship to the *expected bankruptcy cost hypothesis*, Bordeleau and Graham (2010) argue that this concept is also applicable to the impact of liquid assets on profitability. They posit that banks that hold more liquid assets might benefit from a superior perception in funding markets, hence reducing the cost of finance and increasing profitability.

In the context of this current essay, assuming the *expected bankruptcy cost hypothesis* and the *structure-conduct-performance hypothesis* indeed holds, then the holding of liquid assets should impact bank profitability positively. However, there is an opportunity cost associated with the holding of liquid assets given the nature of their low yielding return relative to other assets, and as such they would have a negative effect on profit. Therefore, taken together, it is expected that liquid assets will exhibit a non-linear relationship with bank profitability. The *expected bankruptcy cost hypothesis* and the *structure-conduct-performance hypothesis* will take effect as long as the marginal benefit of holding additional liquid assets outweighs the opportunity cost of their relatively low yielding return.

4.2.3 *Other determinants of bank profitability*

In the literature, bank profitability is usually expressed as a function of a number of other internal and external determinants. Dietrich and Wanzenried (2011) and Claessens and Van Horen (2014) find that bank specific factors, financial structure and macroeocnomic factors may explain changes in bank profitability. *Bank size* is often used to account for any existing diseconomies and economies of scale that may be present in the market. Demirgüc-Kunt et al. (2001) find that the extent to which various financial, economic and legal factors affect bank profitability is closely linked to firm size. Smirlock (1985) finds evidence suggesting that there is a positive and significant relationship between size and profitability. Albertazzi and Gambacorta (2009) also find a positive association between bank profitability and size. In contrast, Tan (2016) suggests that there is a negative impact of bank size on return on assets, net interest margin and pre-tax profit. Whilst Athanasoglou et al. (2008) find no explanatory power in size determining bank profitability.

Most studies dealing with internal determinants tend to include *risk* as a control. Theory suggests that increased risk exposure (particularly credit risk) is usually associated with reduced profitability. Miller and Noulas (1997) find that higher exposure to risk has a negative impact on the profitability for commercial banks in the US. Similarly, Athanasoglou et al. (2008) find that credit risk negatively impacts the profit levels of Greek banks.

Another commonly used internal or bank-specific determinant of profitability is bank capital.[3] Athanasoglou et al. (2008) suggest that capital is positively related to expected earnings when the assumption of perfect capital markets is relaxed. They argue that this positive association is related to the fact that capital is the amount of own funds that is available to maintain and support the bank's business, as such, bank capital serves as a safety net in the event that there are any adverse developments.

Other commonly used internal determinants include *leverage* (see for e.g Demirgüç-Kunt and Huizinga (1999)), *cost management* (e.g. Dietrich and Wanzenried (2011), Liu and Wilson (2010) and García-Herrero et al. (2009)), and diversification (e.g. Demirguc-Kunt et al. (1998)).

Turning the focus to the external determinants of bank profitability, these variables are typically employed as macroeconomic controls. The variables commonly used are the inflation rate, unemployment rate, and a few studies also include the long-term interest rate (see for e.g. Anbar and Alper (2011), Dietrich and Wanzenried (2011), Sufian and Chong (2008)). GDP is also typically employed as a control for the level of economic development. This is discussed separately in section 4.2.4. One of the first papers to address the issue surrounding the relationship between inflation and bank profitability was Revell (1979). He argues that the effect of inflation on profitability largely depends on whether banks' operating expenses increase at a faster rate than inflation. The issue then becomes how mature an economy has to be so that future inflation can be accurately forecasted to allow banks to manage their operating costs accordingly. Along similar lines, Perry (1992) argues

[3] Other work and hypotheses related to relationship between capital and profits were discussed in the previous section.

that the extent to which inflation affects bank profitability ultimately depends on how well inflation expectations are forecasted. Banks that fully anticipate inflation can adjust interest rates accordingly in order to maximise revenues and minimise cost, and as such increase profitability. Bourke (1989) and Molyneux and Thornton (1992) both find that the relationship between profitability and either inflation or long-term interest rate is positive. Bordeleau and Graham (2010) state that the level of unemployment negatively impacts profitability due to a higher probability of default on loans.

4.2.4 *Bank profitability and the cycle*

Amidst concerns over the potential pro-cyclicality of Basel's capital accords, it is interesting to discern the degree to which, if at all, bank profitability is correlated with the business cycle. There are a number of channels through which the business cycle could impact banks' profit. For example, the downturn phase of the cycle could cause a decreased demand for credit and stock market transactions, or provisions necessitated by the deterioration of existing loans. Against this background, it is extremely relevant to analyse how and to what degree is bank profitability affected by the phase of the cycle. Such an analysis could provide a contribution to the ongoing debate about the pro-cyclicality of bank activities. For instance, higher profits provide the ability for banks to increase their capital buffer and subsequently increase lending.

As it stands, there is no general consensus within the literature regarding the association between banks' profitability and the cycle. In an early study, Demirguc-Kunt et al. (1998) use bank-level data for 80 countries over the period 1988-1995 to assess various macroeconomic determinants of commercial bank interest margins and profitability. Their results suggest that the cycle is not statistically important in determining the profitability of banks. Specifically, they find that per capita GDP and the growth rate of real GDP per capita has no significant impact on realized net interest margins and profit. Similarly, Arpa et al. (2001) assess the effects of macroeconomic developments on risk provisions and earnings of Austrian banks for the 1990s and find that net interest income is uncorrelated with real GDP growth.

It is quite reasonable to argue that the variables used (or at least how they are used) by Demirguc-Kunt et al. (1998) and Arpa et al. (2001) are not the most accurate way of capturing the business cycle, and as such could lead to incorrect conclusions. Further, it is risky to rely on the accuracy of these estimates when the series is relatively short.[4] The latter of these two issues is addressed in Bikker and Hu (2012). They use real GDP data for the period 1979-1999 to assess its impact on bank profits. Their findings indicate that both contemporaneous and delayed real GDP growth positively impact bank profit margins. Albertazzi and Gambacorta (2009) also find that bank profits are pro-cyclical. That is, GDP influences banks' ROE, net interest income, and profit before taxes in a positive way.

Dietrich and Wanzenried (2011) attempt to assess which variables best determine bank profitability before and during the crisis - finding that real GDP growth positively impacts banks' ROA when using the entire sample period. However, GDP appears insignificant in determining profits in the pre-crisis (1999-2006) and crisis periods (2007-2009) when estimated separately. Another interesting finding from this paper is the role of loan growth in determining profits. The growth of total loans positively impacts bank profitability across both pre crisis and crisis periods, and is also significant across all years. This finding raises the question about a possible role for the credit cycle in influencing bank profits. Kohlscheen et al. (2018) document similar results on the growth of bank loans, with GDP carrying no such

[4] Both Demirguc-Kunt et al. (1998) and Arpa et al. (2001) use less than 10 years of data to capture the business cycle. These series are not sufficiently long to capture the various peaks and troughs in the cycle.

significance. The authors conclude that the financial cycle plays a more important role in determining bank profits than the business cycle.

In light of these recent findings, this essay will also build on these studies and address the role of both the business and the financial cycle in explaining bank profitability. Importantly, this essay will address the issues regarding how the cycles are estimated and use sufficiently long time series. These particular findings will contribute to the debate surrounding the cyclicality of bank profitability.

4.3 Data

The main data source for the bank-specific characteristics is the SNL Financial Database which is maintained by S&P Global. The database provides comprehensive annual financial information for banks in over 150 countries around the world.

To use the data from the SNL Financial database for empirical analysis, the data had to be edited in the following ways. Given that the focus of the study is on commercial banks, I start by excluding all central banks, investment banks, non-banking credit institutions and securities houses. I limit the study to commercial banks, as different bank types have various characteristics and portfolios that may affect profitability. Next, I eliminate duplicate information. If SNL reports both consolidated and unconsolidated statements, I drop the unconsolidated statement to avoid double counting. Consolidated statements are used in line with the view that internationally active banks take strategic decisions on their global assets and liabilities. Finally, I select banks that have data available for at least three quarters of the sample period on all main variables used throughout the analysis.

In addition to the bank-specific data, the study uses a set of macroeconomic variables to explain bank profitability. The real GDP and inflation were retrieved from the OECD database. The data on credit–to–GDP, property prices, and private credit were all taken from the BIS database. Table 4.1 provides further details on the description of the variables used and their respective sources.

Table 4.1: Description of variables

Variable	Description	Source
Bank level		
Return on assets	Ratio of net income to assets	SNL
Return on equity	Ratio of net income to equity	SNL
Pre-tax profit	Net profit before the effect of income taxes and any after-tax items as a percent of average RWAs	SNL
Liquidity	Liquid assets as a percent of assets	SNL
Leverage	Ratio of total assets to total shareholder's equity	SNL
Risk	Ratio of non-performing loans to total loans	SNL
Size	Natural logarithmic of total assets	SNL
Capital ratio	Total regulatory capital as a percent of risk-weighted assets	SNL
Country level		
Short-term market rate	Interbank rate	OECD
Long-term rate	10 - year bond yield rate	OECD
CPI	Change in consumer price index	OECD
Private credit	Credit to the private, non-financial sector	BIS
GDP	Gross domestic product	OECD
Credit-to-GDP ratio	Ratio of private credit to GDP	BIS
Property prices	Residential property prices	BIS

The sample is then an unbalanced panel dataset of 843 banks from 33 advanced and emerging market economies over the period 2005–2017.[5] The main aim of this study is to assess the impact of liquid assets on bank profitability while controlling for the relevant idiosyncratic bank and macroeconomic variables, particularly those capturing the business and financial cycles. The study considers three profitability indicators: return on assets (ROA), return on equity (ROE) and pre-tax profit as is standard in the literature.

Table 4.2 reports the descriptive statistics for the variables used in the regression analyses. The statistics highlight a few interesting facts about the profitability of the banks in the sample. On average, the sampled banks have a ROA of 0.47% over the entire sample period 2005–2017. The relatively small difference between the mean and the median would suggest that there is not a large profitability difference among the banks in the sample. The second profitability indicator (ROE), however, shows a slight difference. The mean of 6.31% and median of 5.28% would indicate that

[5]Table A10 provides details on the number of banks from each country.

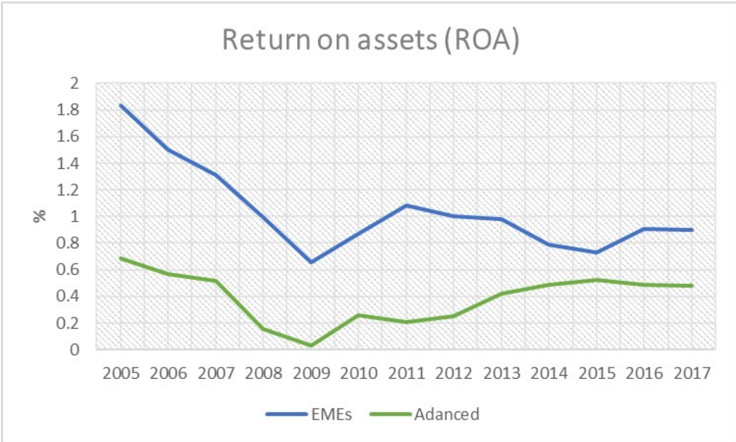
there is some differences in profitability among the banks in the sample. Differences between the ROA and ROE usually reflect factors such as the underlying changes in leverage. The banks in the sample exhibit an average pre-tax profit of 1.33%, with a median amount of 1.29%. Turning to the independent variables, the key bank variable of interest (liquidity) shows that on average, the liquid assets holding of banks in the sample is 28.56%. On average, the capitalisation of banks is 17.16%, which, however, differs among banks, as shown in the median. The log of total assets, which is an indicator of bank size, amount to 16.22% on average. The median of 16.65% would suggest that all the banks in the sample are of similar size, as it relates to total assets. The ratio of non-performing loans to total loans, which is an indicator of the riskiness of banks, amounts to 4.60%, but similar to other variables, there exist large differences among the banks in the sample with respect to this variable. As it relates to the macroeconomic factors, average short and long-term interest rates are 2.12% and 3.36%, respectively. The average inflation rate over the sample period is approximately 0.01%. The correlation matrix for the independent variables can be seen in Table A11.

Table 4.2: Descriptive statistics

Dependent variables: bank profitability	Obs	Mean	Median	Std. Dev.	Min	Max
ROA	9,405	0.469	0.479	0.963	-6.412	4.038
ROE	9,403	5.275	6.313	13.265	-167.240	33.610
Pre-tax profit	7,450	1.329	1.292	2.078	-10.022	12.461
Independent variables	Obs	Mean	Median	Std. Dev.	Min	Max
Liquidity	9,034	28.555	24.986	17.131	0.019	100
Leverage	9,418	20.759	12.940	394.451	-1289.872	35567
Capital ratio	8,459	17.158	14.607	14.649	-5.029	450.350
log of total assets	9,420	16.218	16.652	2.567	4.442	22.022
NPL/loans	8,352	4.596	2.637	7.384	0.000	99.725
Short-term rate	10,820	2.123	0.868	2.507	-0.784	14.757
Long-term rate	10,872	3.364	3.136	2.300	-0.362	22.498
CPI rate	10,577	0.007	0.016	0.058	-0.574	0.155
Hamilton cyclical components						
GDP	10,959	0.008	0.005	0.057	-0.248	0.313
Credit-to-GDP ratio	10,959	0.008	0.008	0.059	-0.312	0.271
Property prices	10,594	0.005	0.003	0.034	-0.100	0.174
Private credit	10,959	0.014	0.016	0.057	-0.195	0.250

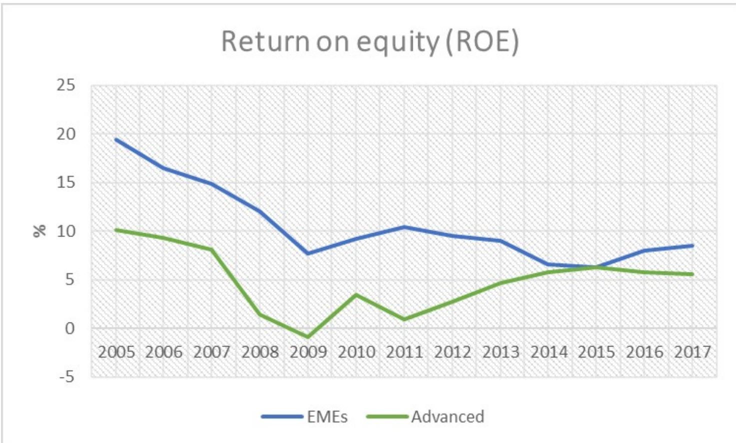
ROA is the most commonly used measure of bank profitability. It shows the profits earned per unit of assets and reflects the management ability to utilise banks' financial and real investment resources to generate profits Hassan and Bashir (2003). As such, ROA has emerged as the key ratio for evaluating bank profitability in the literature (Molyneux and Thornton (1992), Shaffer (2004), Athanasoglou et al. (2008), García-Herrero et al. (2009), Mamatzakis and Bermpei (2016)). Figures 4.1 to 4.3 show the evolution of bank profitability for banks in both advanced and EMEs over the examined period.

Figure 4.1: Evolution of banks' ROA in Advanced and Emerging economies



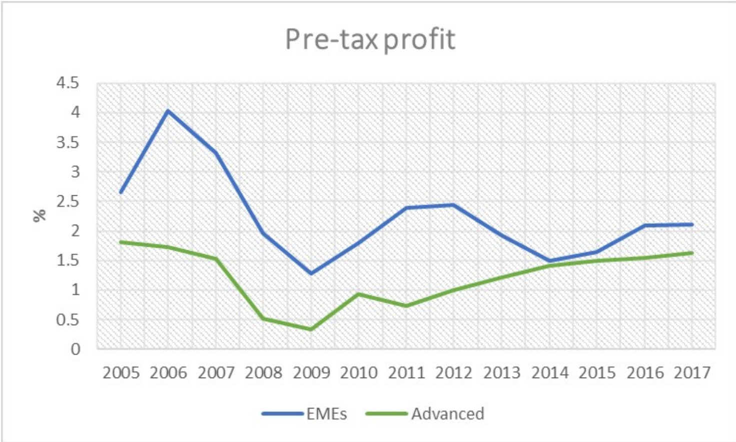
Source: SNL & Author's calculation. Notes: This figure shows the movement of bank profitability, ROA, for EMEs and advanced economies over the sample period 2005 - 2017. ROA is expressed as the ratio of net income to total assets.

Figure 4.2: Evolution of banks' ROE in Advanced and Emerging economies



Source: SNL & Author's calculation. Notes: This figure shows the movement of bank profitability, ROE, for EMEs and advanced economies over the sample period 2005 - 2017. ROE is expressed as the ratio of net income to total equity.

Figure 4.3: Evolution of banks' pre-tax profit in Advanced and Emerging economies



Source: SNL & Author's calculation. Notes: This figure shows the movement of bank profitability, PTP, for EMEs and advanced economies over the sample period 2005 - 2017. PTP is net profit before the effect of income taxes and any after-tax items as a percent of average Risk-weighted assets.

Banking sector performance for both advanced and EMEs, as measured by the average ROA, ROE, and pre-tax profit was exuberant during the period preceding the global financial crisis (Figure 1). This is not surprising considering risk was often neglected – rewarding short-term gains over long-term sustainable returns – and not properly assessed in bank strategies. Credit standards were relaxed, and many banks relied on short-term wholesale markets to fund activities (Buch et al., 2018). As such, banking system assets, credit and profits were at very high levels. However, since 2009, profitability has remained below pre-crisis levels. In what follows, this essay analyses the impact of banks' liquidity on these indicators of bank profitability, controlling for other bank and country idiosyncrasies, particularly the extent to which profitability is affected by the business and financial cycle. The study relies on the ROA as the benchmark profit indicator, however, it checks whether results hold for ROE and pre-tax profit.

4.3.1 Constructing the business and financial cycles

As previously mentioned, there is no clear consensus within the literature regarding a definitive relationship between banks' profitability and the cycle. Furthermore, the potential role of the financial as opposed to the business cycle in predicting banks' profitability is largely ignored. Against this background, this current study constructs estimates for both the business and financial cycles to evaluate their respective impact on the profitability of banks.

The study takes GDP as the representative variable for the business cycle. I recognise and acknowledge that a multivariate approach would probably be more suitable, such as the finance-neutral output gap of Borio et al. (2016) or the finance-augmented cycle of Montagnoli et al. (2018). However, for simplicity, and conforming to common practice in this literature, this study will utilise the univariate approach.

Unlike the business cycle, the financial cycle has been far less researched and defined. Further, there is no agreement on the most reliable econometric method to analyse its statistical properties, this is usually left to the preference of the researcher. Therefore, this study looks at a number of series to attempt to characterise it. Studies such as Dell'Ariccia et al. (2012), Jordà et al. (2013) and Taylor (2015) have used credit to capture the financial cycle, on the grounds that credit captures the boom-bust of the financial sector. A variable commonly used in policy analysis is the credit-to-GDP ratio. More often, researchers tend to look at measures of credit and asset prices, most notably real estate prices (see for example Claessens et al. (2011) and Claessens et al. (2012)). In Drehmann et al. (2012), credit aggregates (particularly the credit-to-GDP ratio) are used as a proxy for leverage, while property prices are used as a measure of available collateral. Stremmel (2015) finds that the key ingredients of the best fitted financial cycle measure for Europe include credit-to-GDP ratio, credit growth, and house prices to income ratio.

This study follows Drehmann et al. (2012), Borio (2014), and Stremmel (2015) in using three financial variables to approximate the financial cycle.[6] These are: (i) credit to the private, non-financial sector; (ii) credit-to-GDP ratio; and (iii) property prices. All the macroeconomic data used to construct the business and financial cycles span the period 1980–2017. Using such long series allows for capturing various peaks and troughs, and thus better approximates the cycles. The series used to approximate the cycles are all in real terms (CPI deflated) and in natural logarithmic form. This of course excludes the credit-to-GDP ratio which is expressed in percentage points. Further, they are all normalised to their respective values in 2010 to maintain comparability.

To construct the cycles, the study uses the recent filter-based method proposed by Hamilton (2017). The most commonly used technique in literature is the HP-filter. However, despite its popularity, it comes with several drawbacks that must be considered when deciding whether to use this approach. For example, Hamilton (2017) argues that the HP-filter involves several levels of differences, so for a random walk process, subsequent observed patterns are a mere by-product of having applied the filter rather than reflecting the underlying data generating process. He further suggests that the filtered values at the end of the sample vary significantly from those in the middle, and as such are characterised by spurious dynamics. Hamilton (2017) finally adds that the HP-filter typically produces values for the smoothing parameter which are vastly at odds with common practice.

In light of this, Hamilton (2017) suggests an alternative concept of deriving the cyclical component of a possibly nonstationary series. Specifically, he imposes that the cyclical component of a possible nonstationary series should address the question of how different is the value at date $t+h$ from the value that would be expected based

[6]In extending this paper, I will adopt a multivariate approach where all three variables will be combined in a single measure to construct a proxy of the financial cycle.

on its behaviour through date t.[7] Therefore, he suggests that if an OLS regression of y_{t+h} is regressed against some constant and the $p = 4$ most recent values of y as of date t,

$$y_{t+h} = \beta_0 + \beta_1 y_t + \beta_2 y_{t-1} + \beta_3 y_{t-2} + \beta_4 y_{t-3} + v_{t+h} \tag{4.1}$$

the residuals

$$\widehat{v}_{t+h} = y_{t+h} - \widehat{\beta}_0 - \widehat{\beta}_1 y_t - \widehat{\beta}_2 y_{t-1} - \widehat{\beta}_3 y_{t-2} - \widehat{\beta}_4 y_{t-3} \tag{4.2}$$

provide an acceptable approach to gain the transient component for a broad class of underlying processes.

Hamilton (2017) argues that this proposed procedure holds a few advantages over the much used HP-filter. First, unlike the cyclical component of the HP-filter, the value of $\widehat{v}_{t+h}$ will be difficult to predict from variables that pre-date time t. Second, the value of $\widehat{v}_{t+h}$ is a model-free and assumption-free summary of the data. Thus, regardless of how the data was generated, as long as $(1 - L)^d y_t \leq 4$, there exists a population projection of y_{t+h} on $(y_t, y_{t-1}, y_{t-2}, y_{t-3}, 1)'$, which can be used to consistently estimate a cyclical component from the data. Therefore, borrowing from Hamilton (2017) approach, this study extracts the cyclical component from real GDP, property prices, private credit, and credit-to-GDP ratio, in order to provide proxies for the business and financial cycles.

[7] This concept is related to the definition of the trend component of y_t as $g_t = \lim_{h\to\infty} \lim_{p\to\infty} E(y_{t+h}|y_t, y_{t-1}, ..., y_{t-p+1})$ in Beveridge and Nelson (1981). This limit exists and can be calculated provided that $(1 - L)y_t$ is a mean-zero stationary process.

4.4 Stylised facts

In Figure 4.4, banks' average return on assets is plotted against each series representing the business and financial cycle.[8] The experiment clearly suggests that cyclical patterns exist in the evolution of banks' profitability over the sample period. There appears to be a positive co-movement between profitability and the business cycle (upper left panel of Figure 4.4).

Figure 4.4: Cyclical evolution of banks' profitability

Source: SNL & Author's calculation. Notes: This figure plots the movement of bank profitability (ROA) vs measures of the macroeconomic cycles over the sample period 2005 - 2017.

A positive co-movement is also evident between ROA and property prices (bottom left panel). The relationship is far less discernible between ROA and private credit (top right panel) and the credit-to-GDP ratio (bottom right panel), respectively. As these graphs merely represent a simplistic approach to understanding the

[8] See Figure A2 and Figure A3 in the appendix for other measures of profitability plotted against macroeconomic cycles.

cyclical behaviour of banks' profitability, further empirical investigation will seek to provide a better analysis of the relationship.

Figure 4.5: Bank liquidity and the macroeconomic cycles

Source: SNL & Author's calculation. Notes: This figure shows the movement of bank liquid assets and measures of the macroeconomic cycles.

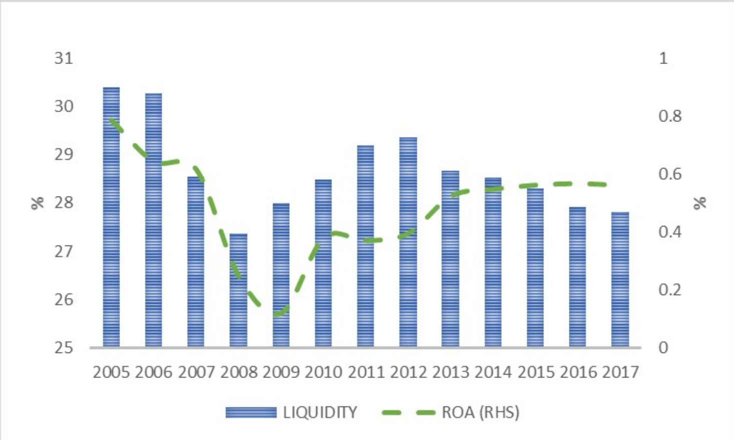
Bank liquidity and measures of the business and financial cycles are depicted in Figure 4.5. Measures of the cycle are constructed using the previously mentioned Hamilton (2017) filter. In general, a useful starting point would be to examine the dynamic cross-correlations between liquidity and each of the macroeconomic series. It turns out that liquidity is weakly correlated with all four of these macroeconomic series (see Table A11). Looking at the movements between liquidity and GDP (top-left), it appears that flows of liquidity leads the business cycle, up until about 2011. A similar evolution takes place between liquidity and property prices (bottom-left) up to the same period. Beyond this point, the relationship appears to be negative, particularly between liquidity and GDP. The depictions of the relationship between liquidity and the remaining two cyclical measures (private credit, credit-to-GDP) are far less discernible.

Also in Figure 4.5, it appears that banks' holding of liquid assets were on a decline leading up to the financial crisis. Banks in EMEs in particular appeared to swiftly relinquish these low yielding assets leading up to the crisis.[9] Bordeleau and Graham (2010) find similar movements in the liquid assets of US and Canadian banks in the period leading up to the crisis. Committee et al. (2009) suggests that this behaviour might reflect the fact that, in the build up to and during the crisis, liquid assets were associated with mortgage-backed securities that quickly became illiquid because of the asset quality deterioration. However, following the liquidity shock that occurred during the 2007–2009 period, banks began adjusting their holdings of cash and other liquid assets. In fact, it was during the midst of the crisis that various regulatory authorities recognized the need to develop a consistent standard to monitor and improve banks' liquidity position. Consequently, the G20 suggested that the BCBS should implement a global framework to promote stronger liquidity buffers at financial institutions, including cross-border institutions. The consultations led to the introduction of two regulatory standards aimed at addressing liquidity risk both in the short and long term. The *liquidity coverage ratio* aimed at ensuring that banks hold sufficiently high quality liquid assets to withstand acute stress scenarios lasting one month. In the longer term, the *net stable funding ratio* would increase incentives for banks to fund themselves using more stable sources on a structural basis. In broad terms, these tools are designed to ensure banks are equipped to withstand idiosyncratic and system-wide liquidity shocks. The calibration of this regulatory standard is key to its impact on banks and the financial system as a whole. As such, it is important to understand the

[9] See Figure A1 in appendix for individual series of liquid asset holdings for EMEs and advanced economies.

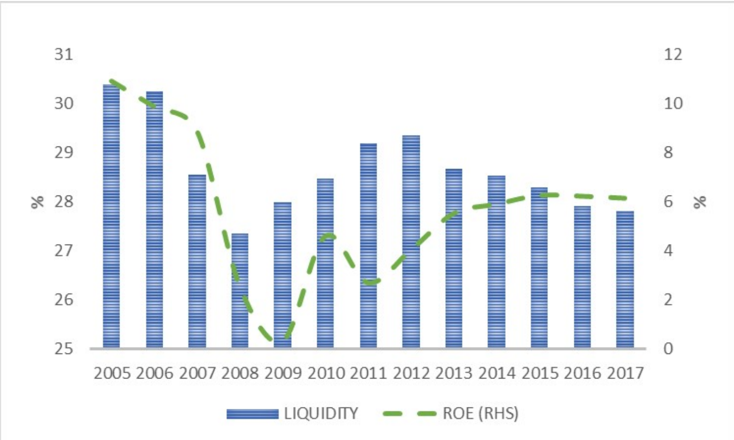
impact that a change in banks' liquid asset holdings has on its profitability.

Figure 4.6: Banks' liquid assets holdings and profitability (ROA)



Source: Author's calculation. Notes: This figure shows the movement of average bank liquidity holdings and profitability (as measured by return on assets) over the sample period 2005 - 2017. Liquidity is the ratio of banks' liquid assets to total assets, while ROA is the ratio of net income to assets.

Figure 4.7: Banks' liquid assets holdings and profitability (ROE)



Source: Author's calculation. Notes: This figure shows the movement of average bank liquidity holdings and profitability (as measured by return on equity) over the sample period 2005 - 2017. Liquidity is the ratio of banks' liquid assets to total assets, while ROA is the ratio of net income to equity.

Figure 4.8: Banks' liquid assets holdings and profitability (PTP)

Source: Author's calculation. Notes: This figure shows the movement of average bank liquidity holdings and profitability (as measured by pre-tax profit) over the sample period 2005 - 2017. Liquidity is the ratio of banks' liquid assets to total assets, while PTP is net profit before the effect of income taxes and any after-tax items as a percent of average Risk-weighted assets.

Combining the information gathered from Figures 4.6 to 4.8, it is unclear through graphical representation what the impact of additional liquid assets has been on the profitability of the sampled banks. As such, the study provides an empirical approach to investigate this relationship while accounting for other relevant factors at the bank and country level.

4.5 Methodology

To carry out the empirical investigation, profitability is regressed against a non-linear expression of liquid assets, along with a set of other bank specific and macroeconomic control variables. Liquid asset holdings is modelled as a non-linear polynomial of order two against the background that, despite being credit risk-free, they are low yielding and therefore have a significant opportunity cost. That is, they represent a 'lost' opportunity for more income from more rewarding uses of funds. The baseline model is therefore given by:

$$\pi_{i,j,t} = \alpha + \phi_1 \pi_{i,j,t-1} + \beta_1 liquidity_{i,j,t-1} + \beta_2 liquidity^2_{i,j,t-1} + \beta_3 leverage_{i,j,t-1} + \beta_4 risk_{i,j,t} + \beta_5 size_{i,j,t} + \beta_6 capital_{i,j,t} + \lambda_1 SR_{i,t} + \lambda_2 LR_{i,t} + \lambda_3 CPI_{i,t} + \lambda_4 cycle_{i,t} + \epsilon_{i,j,t} \tag{4.3}$$

where

- i represents each bank in the sample;
- j represents the country in which each bank is located;
- t denotes each year in the sample, spanning 2005 to 2017;
- thus, $\pi_{i,j,t}$ represents the profitability measure of bank i, located in country j, at time t;
- $\pi_{i,j,t-1}$ is the one-period lagged profitability;
- thus ϕ will inform the speed of adjustment to equilibrium;
- $\epsilon_{i,j,t}$ is the disturbance.

A value of ϕ between 0 and 1 suggests that profits are persistent, but will eventually approach normal levels. $Liquidity_{i,j,t-1}$, along with its squared term, which are the main bank specific control variables of interest, is the ratio of bank liquid assets to total assets. Both these variables enter with a lag since creditors usually observe the relative liquidity position of a bank before making a judgement on its credit risk. $leverage_{i,j,t-1}$ is the ratio of total assets to shareholder's equity. $Risk_{i,j,t}$ is included to proxy banks' credit risk and is the ratio of non-performing loans to total loans. $Size$ is included to help answer the question of which size optimizes bank profitability and it is measured as the log of total assets. $Capital_{i,j,t}$ represents the ratio of regulatory capital and risk-weighted assets of the respective bank. $SR_{i,t}$ represents the short-term interest rate and is proxied by the interbank rate. $LR_{i,t}$ is the long-term rate and corresponds to the 10-year bond yield rate. $CPI_{i,t}$ is the inflation rate. The final macroeconomic control, $cycle_{i,t}$, will be crucial in explaining the cyclical behaviour of bank profits and inform whether it is the business or financial cycle that explains the variations in profitability.

In static relationships, the literature normally applies least squares techniques on fixed effects or random effects models. However, for dynamic relationships these methods produce estimates that are biased and inconsistent (Baltagi, 2008). Therefore, this experiment uses techniques for dynamic panel estimation that are able to deal with the biases and inconsistencies of the estimates. In addition to issues of inconsistencies and biases, the estimation of bank profitability also raises concerns regarding endogeneity. For example, García-Herrero et al. (2009) argue that more profitable banks might be able to increase their equity more easily by retaining profits. Along similar lines, they could also spend more on advertising and increase their size, which in turn could affect profitability. Endogeneity may also be present with regards to liquidity on the grounds that profits could be a potential source of additional liquidity for banks.

Taking the above issues into consideration, this study employs the generalised method of moments (GMM) following Arellano and Bover (1995) and Blundell and Bond (1998), also known as the system GMM estimator. The estimator is designed for short, wide panels, and to fit linear models with one dynamic dependent variable, additional controls, and fixed effects. The system GMM estimator exploits an assumption about the initial conditions to obtain moment conditions that remain informative even for persistent series, and has been shown to perform well in simulations. Additionally, the method accounts for endogeniety. Lagged values of the dependent variable both in levels and in differences are used as instruments, as well as lagged values of other regressors which could potentially suffer from endogeneity. Specifically, I treat bank capital, risk and leverage as endogenous variables. This is against the background that more profitable banks could increase capital easier by retaining profits. Lee and Hsieh (2013) further argue that under the moral hazard hypothesis, risk and the level of capital should be treated as endogenous when investigating profits.[10] The macroeconomic controls - GDP, inflation, and interest rates are treated as exogenous.

GMM estimators offer both one- and two-step variants. This study uses the two-step estimator, which is generally more efficient, particularly for the system GMM. The study employs Windmeijer (2005) finite-sample correction to the reported standard errors, without which they tend to be severely downward biased. Finally, two post-estimation tests are reported to validate the appropriateness of the GMM estimations. The first is the Arellano and Bond (1991) test for autocorrelation of errors. An important point to note is that the consistency of the GMM estimator depends on the errors being serially uncorrelated, i.e., $E(\Delta\epsilon_{i,j,t}, \Delta\epsilon_{i,j,t-2} = 0)$. Thus, Arellano and Bond (1991) suggest testing that the second-order auto-covariances for all periods in the sample are zero. The other test is the Hansen (1982) J test statistic for over-identifying restrictions. The J-test is related to the order condition of identification and tests the null that instruments are uncorrelated with the error term. Failure to reject the null hypothesis indicates that the chosen instruments are exogenous.

[10] Athanasoglou et al. (2008) suggest that credit risk should be modelled as a predetermined variable in assessing profitability.

4.6 Empirical results

Table 4.3 presents the empirical results from estimating Eq(4.3) for the main profitability measure, ROA. In *Panel A*, estimates of the business and financial cycle are presented separetly in columns I through to IV. *In Panel B*, the study performs a "horse race" between the business cycle and each measure of the financial cycle. The first column includes a business cycle measure, which is the cyclical component of GDP derived using the Hamilton (2017) filter. Columns II through IV include credit-to-GDP ratio, private credit, and property prices, respectively, as measures of the financial cycle.

Table 4.3: Empirical results - Return on Asset (ROA) as profit indicator

Dependent variable (ROA)	Panel A				Panel B		
	I	II	III	IV	V	VI	VII
$ROA_{i,j,t-1}$	0.458***	0.514***	0.482***	0.498***	0.488***	0.444***	0.441***
	(0.053)	(0.042)	(0.047)	(0.042)	(0.047)	(0.054)	(0.053)
$Liquidity_{i,j,t-1}$	0.094**	0.080***	0.045*	0.075***	0.064**	0.087**	0.083**
	(0.040)	(0.029)	(0.025)	(0.025)	(0.029)	(0.041)	(0.037)
$Liquidity^2_{i,j,t-1}$	-0.001**	-0.001***	-0.001*	-0.001***	-0.001**	-0.001**	-0.001**
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
$Leverage_{i,j,t-1}$	-0.009	-0.000	-0.010	0.000	-0.009**	-0.009	-0.009
	(0.007)	(0.000)	(0.008)	(0.000)	(0.004)	(0.008)	(0.007)
$Risk$	-0.024**	-0.023**	-0.022***	-0.018**	-0.019***	-0.024**	-0.027***
	(0.010)	(0.009)	(0.008)	(0.007)	(0.007)	(0.010)	(0.010)
$Size$	-0.012	-0.007	-0.001	-0.017	-0.000	-0.009	-0.010
	(0.020)	(0.019)	(0.015)	(0.017)	(0.015)	(0.020)	(0.019)
$Capital\ ratio$	-0.003	0.030**	-0.002	0.033*	0.015	-0.003	-0.003
	(0.006)	(0.015)	(0.004)	(0.020)	(0.010)	(0.006)	(0.006)
$Short-term\ market\ rate$	-0.020	-0.073***	-0.017	0.006	-0.010	-0.010	-0.018
	(0.034)	(0.025)	(0.029)	(0.029)	(0.023)	(0.035)	(0.032)
$10-year\ bond\ yield$	0.123***	0.139***	0.099***	0.120***	0.095***	0.114***	0.131***
	(0.038)	(0.030)	(0.033)	(0.029)	(0.023)	(0.039)	(0.038)
CPI	-5.589***	-3.823**	-5.420***	-5.386**	-5.987***	-6.055***	-5.465***
	(1.563)	(1.682)	(1.501)	(2.123)	(1.465)	(1.567)	(1.509)
GDP	1.425				0.252	1.164	0.926
	(0.907)				(0.573)	(0.885)	(0.922)
$credit-to-GDP$		1.215**			1.205**		
		(0.559)			(0.509)		
$Credit$			1.823***			0.916**	
			(0.482)			(0.433)	
$Property\ prices$				5.801***			2.848**
				(1.316)			(1.443)
$Constant$	-0.645	-1.412***	-0.137	-1.424**	-0.726	-0.536	-0.626
	(0.581)	(0.538)	(0.364)	(0.612)	(0.492)	(0.575)	(0.552)
No. of banks	760	760	760	760	760	760	760
Observations	4,553	4,553	4,553	4,553	4,553	4,553	4,542
No. of instruments	76	73	77	73	78	76	75
AB test for AR(2)	0.85	0.36	0.94	0.44	0.71	0.89	0.74
Hansen J test	0.28	0.10	0.32	0.12	0.16	0.43	0.49

This table analyzes the impact of banks' liquid asset holdings on profitability using the system GMM estimator of Arellano-Bover. Robust standard errors are reported in parantheses. *Liquidity* is the ratio of liquid assets to total assets. *Leverage* is the ratio of assets to total shareholders' equity. *Risk* is the ratio of non-performing loans to total loans. *Size* is the log of total assets. *Capital ratio* is the ratio of regulatory capital to risk-weighted assets. *Short-term market rate* is proxied by the 3-month interbank rate. *10-year bond yield* is a proxy for long-term market interest rate. *CPI* measures the rate of inflation. *GDP* is the cyclical component of real GDP. *credit-to-GDP* is the cyclical component of the credit-to-GDP ratio. *Credit* is the cyclical component of credit to the private non-financial sector. *Property prices* is the cyclical component of residential property prices. All the cyclical components of the aforementioned variables are derived using the Hamilton (2017) filter. ***, ** and * denote $p < 0.01$, $p < 0.05$ and $p < 0.1$ respectively.

The highly significant coefficient of the lagged dependent variable validates the dynamic character of the model specification. ϕ takes a value of approximately 0.46, which suggests that bank profits persist to a moderate extent. Turning to the main bank variable of interest, the estimated relationship between liquid assets and bank profitability is positive and significant. However, its quadratic term ($liquidity^2$) enters with a negative coefficient, and also statistically significant at the 5% level.

Collectively, these results would suggest that, ceteris paribus, profitability increases for banks holding some liquid assets, however, at some point, holding further liquid assets reduces the banks' profitability. This finding is consistent with Bordeleau and Graham (2010) who find similar results for commercial and bank holding companies in Canada and the U.S. The authors argue that this finding is line with the idea that funding markets may reward banks for holding some liquid assets, however at a certain point this benefit starts being outweighed by the opportunity cost of holding these lower-yielding assets.

The coefficient on the cyclical indicator in column 1 turns out, unexpectedly, to be statistically insignificant. This suggests that the business cycle is not important in explaining variations in bank profitability. This contrasts various studies in the literature such as Albertazzi and Gambacorta (2009), Dietrich and Wanzenried (2011), and Bikker and Hu (2012), among others. Yet, it lends support to the earlier findings of Demirguc-Kunt et al. (1998), Arpa et al. (2001), and most recently Kohlscheen et al. (2018). While there are evident drawbacks in how Demirguc-Kunt et al. (1998) and Arpa et al. (2001) construct and estimate their business cycle measure, this current study identifies those limitations and tries to adjust for them accordingly. As such, the findings of this essay are consistent with studies in the literature that fail to find any significant association between the business cycle and bank profitability. The coefficients on the financial cycle measures in the other columns could provide some evidence of the cyclical behaviour of bank profits.

Before examining the financial cycle indicators in the remaining columns, the other control variables in column I provide some interesting findings. As expected, the *risk* variable, which is a non-performing loans ratio, enters with a negative and significant coefficient. This implies that banks attempting to maximise profits adopt a risk-averse approach. This is usually through effective screening and monitoring credit risk. As for bank *size*, the coefficient appears statistically insignificant. Athanasoglou et al. (2008) similarly finds that the effect of bank size on profitability is not important for a sample of Greek banks. They argue that small banks usually try to grow faster, sometimes even at the expense of their profitability. They also present the argument that newly established banks are not particularly profitable in their first years of operation, as greater emphasis is placed on gaining market share rather than improving profitability. Along similar lines, Berger et al. (1987) suggest that little cost savings can be had by increasing the size of a banking institution. However, a number of studies including Rime and Stiroh (2003) and Smirlock (1985) argue that growth in bank size is positively associated with bank profitability.

The introduction of financial cycle measures in columns II to IV provides interesting insights on the cyclical behaviour of bank profits. All three financial variables ($credit - to - GDP$, *private credit*, *and property prices*) appear to have a positive and highly significant association with profitability. Thus, in contrast to the effects of the business cycle on ROA, which appeared statistically insignificant, banks' profitability responds positively to measures of the financial cycle. Furthermore, the results in *Panel B* support this claim. In a horse-race between GDP and each of the financial cycle measures, the latter outperform GDP in terms of explaining changes in bank profitability. This finding is somewhat similar to that of Kohlscheen et al. (2018). They find that, in a horse-race between GDP growth and credit growth in explaining profits, credit growth comes out ahead. In other words, they find that GDP growth provides no explanatory power in bank profits, while credit growth seems to positively impact the profitability of the sampled banks.

Another interesting finding coming out of Table 4.3 is the role of interest rates. As shown in columns I through IV, long-term interest rates have a positive impact on profitability, while the impact of short-term interest rates is less clear. In column

II, a negative impact of short-term rates on profits is observed, however, the association is insignificant in all other specifications. The findings of a positive effect of long-term rates on profitability are consistent with Albertazzi and Gambacorta (2009) and Kohlscheen et al. (2018). Kohlscheen et al. (2018) argue that reducing short-term rates reduces funding costs, while an increase in long-term rates usually increases revenues, as banks can charge borrowers higher rates. For short-term rates, the conclusions in the literature are ambiguous. For example, Demirgüç-Kunt and Huizinga (1999) find a positive impact of short-term rates on profits, the findings in Hancock (1985) and Kohlscheen et al. (2018) are negative, while for Albertazzi and Gambacorta (2009) the impact is insignificant. In a recent paper, Borio et al. (2017) find that short-term rates can negatively impact net interest income. They argue that changes in the level of market rates will also have quantity effects, therefore influencing the volume of loans and deposits. This they argue could cause the demand for loans to become more responsive (elastic) to interest rates than for deposits, and at some point higher interest rates will erode profitability.[11]

Meanwhile, the results suggest a negative and significant impact of the inflation rate on profitability. This finding contrasts most in the empirical literature (e.g. Bourke (1989); Molyneux and Thornton (1992); Demirguc-Kunt et al. (1998)) which typical reports a positive relationship. More recently, Bordeleau and Graham (2010) find that inflation exhibits a negative relationship with profitability for a sample of Canadian and U.S banks. They argue that since banks typically lend long and borrow short, it is to be expected that higher inflation would decrease their profit margins.

The Hansen and the serial-correlation tests do not reject the null hypothesis of correct specification, which means that the chosen instruments are valid and no

[11] Another explanation of the differing impact of short and long-term interest rates on bank profits is related to the notion of maturity transformation (the fact that banks typically have assets with longer duration than their liabilities; see Diamond and Dybvig (1983)).

serial correlation exists.

Table 4.4 reports the regression results for the second profitability measure, ROE. The results of these regressions confirm to a large extent the key results discussed for ROA above. The sign and significance of most variables remain consistent with those in the baseline specification of Table 4.3.

Table 4.4: Return on Equity (ROE) as profit indicator

Dependent variable (ROE)	Panel A				Panel B		
	I	II	III	IV	V	VI	VII
$ROE_{i,j,t-1}$	0.275***	0.352***	0.283***	0.347***	0.266***	0.267***	0.253***
	(0.071)	(0.056)	(0.074)	(0.061)	(0.067)	(0.073)	(0.069)
$Liquidity_{i,j,t-1}$	1.181**	0.980**	0.854*	1.010**	1.201**	1.096**	1.016**
	(0.535)	(0.473)	(0.466)	(0.438)	(0.488)	(0.552)	(0.497)
$Liquidity^2_{i,j,t-1}$	-0.016**	-0.012**	-0.011*	-0.011**	-0.016**	-0.015*	-0.013*
	(0.007)	(0.006)	(0.007)	(0.005)	(0.007)	(0.008)	(0.007)
$Leverage_{i,j,t-1}$	-0.116	-0.001	-0.092	0.011	-0.102	-0.124	-0.065
	(0.079)	(0.004)	(0.090)	(0.008)	(0.085)	(0.080)	(0.091)
$Risk$	-0.380***	-0.395***	-0.381***	-0.260**	-0.333**	-0.390***	-0.403***
	(0.125)	(0.123)	(0.118)	(0.109)	(0.137)	(0.127)	(0.126)
$Size$	0.086	0.244	0.120	0.047	0.102	0.153	0.125
	(0.264)	(0.286)	(0.246)	(0.287)	(0.256)	(0.261)	(0.223)
$Capital\ ratio$	0.019	0.523***	0.024	0.575*	0.044	0.013	0.012
	(0.117)	(0.203)	(0.108)	(0.317)	(0.112)	(0.109)	(0.108)
$Short-term\ market\ rate$	0.057	-1.130***	0.189	0.624	0.109	0.128	-0.065
	(0.492)	(0.408)	(0.489)	(0.458)	(0.466)	(0.484)	(0.417)
$10-year\ bond\ yield$	1.155**	1.663***	1.032**	1.253***	0.979**	1.069**	1.312***
	(0.469)	(0.429)	(0.473)	(0.368)	(0.439)	(0.458)	(0.411)
CPI	-6.692***	-3.322	-8.710***	-8.299***	-7.914***	-7.089***	-6.596***
	(1.764)	(2.197)	(1.960)	(3.012)	(1.898)	(1.798)	(1.741)
GDP	16.920				8.785	10.997	12.964
	(10.952)				(9.961)	(10.331)	(9.949)
$credit-to-GDP$		36.198***			17.398**		
		(10.653)			(8.013)		
$Credit$			13.830*			8.633*	
			(7.116)			(5.120)	
$Property\ prices$				1.197***			0.175*
				(0.211)			(8.985)
$Constant$	-12.693	-25.393***	-8.598	-26.367***	-13.446*	-11.594	-11.769*
	(7.794)	(7.372)	(7.083)	(8.321)	(7.645)	(7.812)	(7.102)
No. of banks	760	760	760	760	760	760	760
Observations	4,553	4,553	4,553	4,553	4,553	4,542	4,553
No. of instruments	76	73	74	73	78	79	81
AB test for AR(2)	0.86	0.57	0.86	0.72	0.80	0.88	0.69
Hansen J test	0.19	0.09	0.14	0.11	0.15	0.18	0.13

This table analyzes the impact of banks' liquid asset holdings on profitability using the system GMM estimator of Arellano-Bover. Robust standard errors are reported in parantheses. *Liquidity* is the ratio of liquid assets to total assets. *Leverage* is the ratio of assets to total shareholders' equity. *Risk* is the ratio of non-performing loans to total loans. *Size* is the log of total assets. *Capital ratio* is the ratio of regulatory capital to risk-weighted assets. *Short-term market rate* is proxied by the 3-month interbank rate. *10-year bond yield* is a proxy for long-term market interest rate. *CPI* measures the rate of inflation. *GDP* is the cyclical component of real GDP. *credit-to-GDP* is the cyclical component of the credit-to-GDP ratio. *Credit* is the cyclical component of credit to the private non-financial sector. *Property prices* is the cyclical component of residential property prices. All the cyclical components of the aforementioned variables are derived using the Hamilton (2017) filter. ***, ** and * denote $p < 0.01$, $p < 0.05$ and $p < 0.1$ respectively.

More specifically, similar to the ROA, the coefficient on the one period lag of ROE suggests that this profitability indicator is also mildly persistent. As it relates to the key bank variable of interest, the sign and significance of the linear and quadratic liquidity term confirms the non-linear relationship between liquidity and profitability. The impact of bank risk remains negative and significant throughout, whilst there is still no evidence of a significant impact of either leverage or bank size on profitability. A positive impact of bank capital on profitability is again observed in columns II and IV.

Similar to ROA, the relationship between long-term rates and ROE is positive and significant. For short-term interest rates, a negative and significant coefficient can be seen in the second specification, however, all other specifications report no significant impact of this variable on bank profitability. Again, the inflation rate negatively impacts bank profitability when ROE is used as the profit indicator.

The cyclicality of ROE in Table 4.4 is broadly in line with the cyclical behaviour identified for ROA in Table 4.3. That is, the proxy for the business cycle in column I has no significant effect on profitability. On the other hand, the credit-to-GDP ratio, private credit, and property prices all have a positive and significant impact on ROE. In addition, *Panel B* of Table 4.4 demonstrates that each financial cycle indicator comes out ahead of the business cycle measure in explaining profitability. This serves to buttress the previous findings that bank profitability responds to the financial cycle and not the business cycle.

Once more, the regressions pass both the Arellano-Bond test for autocorrelation of order 2 and the Hansen J test for over-identifying restrictions.

Table 4.5 reports the regression results for another profitability measure, pre-tax profit. Overall, the results of these regressions confirm to a large extent the results of the previously discussed profitability indicators. The only notable difference is the insignificance of the financial cycle indicator in column II. The cyclical component of private credit does not appear to have any statistical significance in explaining changes in pre-tax profits. This finding is also borne out in the horse-race in column VI. That aside, all the other bank-specific and macroeconomic variables are largely in line with those reported in the previous tables, in terms of sign and significance.

Table 4.5: Pre-tax profit as profit indicator

Dependent variable (Pre-tax profit)	Panel A				Panel B		
	I	II	III	IV	V	VI	VII
$Pre-tax\ profit_{i,j,t-1}$	0.538***	0.495***	0.513***	0.506***	0.519***	0.499***	0.533***
	(0.090)	(0.077)	(0.078)	(0.082)	(0.087)	(0.082)	(0.098)
$Liquidity_{i,j,t-1}$	0.230*	0.239**	0.310**	0.290**	0.192*	0.171*	0.116
	(0.136)	(0.108)	(0.137)	(0.142)	(0.104)	(0.094)	(0.096)
$Liquidity^2_{i,j,t-1}$	-0.003*	-0.003**	-0.004**	-0.004*	-0.003*	-0.003*	-0.002
	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)
$Leverage_{i,j,t-1}$	-0.018	-0.000	-0.001	-0.000	-0.021	0.003	0.008
	(0.015)	(0.001)	(0.001)	(0.001)	(0.013)	(0.012)	(0.011)
$Risk$	-0.033	-0.054**	-0.058***	-0.061***	-0.028	-0.047*	-0.049*
	(0.022)	(0.021)	(0.020)	(0.021)	(0.021)	(0.029)	(0.028)
$Size$	0.046	-0.006	0.003	-0.006	0.050	0.019	0.054
	(0.057)	(0.051)	(0.058)	(0.061)	(0.054)	(0.048)	(0.047)
$Capital\ ratio$	0.092***	0.115***	0.111***	0.106***	0.097***	0.020	0.019
	(0.032)	(0.034)	(0.041)	(0.040)	(0.028)	(0.019)	(0.019)
$Short-term\ market\ rate$	-0.020	-0.234***	-0.095	-0.144**	-0.068	-0.043	-0.086
	(0.072)	(0.075)	(0.070)	(0.065)	(0.075)	(0.079)	(0.081)
$10-year\ bond\ yield$	0.121	0.313***	0.317***	0.359***	0.123	0.163*	0.193*
	(0.082)	(0.088)	(0.103)	(0.099)	(0.076)	(0.099)	(0.100)
CPI	-3.142	-7.723	-16.238***	-14.246*	-6.416*	-9.280**	-7.794**
	(4.196)	(6.192)	(6.179)	(7.383)	(3.586)	(3.731)	(3.587)
GDP	4.376				0.712	-1.068	-2.943
	(3.025)				(2.076)	(2.201)	(2.517)
$credit-to-GDP$		6.808**			6.677***		
		(3.087)			(2.297)		
$Credit$			-2.433			0.672	
			(1.835)			(1.100)	
$Property\ prices$				2.852**			3.606**
				(1.380)			(1.757)
$Constant$	-4.425**	-5.004***	-5.934***	-5.600***	-4.140***	-2.017	-1.781
	(1.788)	(1.636)	(2.063)	(1.975)	(1.523)	(1.351)	(1.365)
No. of banks	734	734	734	734	734	734	734
Observations	4,730	4,730	4,730	4,730	4,730	4,730	4,730
No. of instruments	72	71	71	71	73	79	79
AB test for AR(2)	0.16	0.79	0.28	0.43	0.36	0.18	0.17
Hansen J test	0.19	0.12	0.08	0.11	0.14	0.27	0.30

This table analyzes the impact of banks' liquid asset holdings on profitability using the system GMM estimator of Arellano-Bover. Robust standard errors are reported in parantheses. *Liquidity* is the ratio of liquid assets to total assets. *Leverage* is the ratio of assets to total shareholders' equity. *Risk* is the ratio of non-performing loans to total loans. *Size* is the log of total assets. *Capital ratio* is the ratio of regulatory capital to risk-weighted assets. *Short-term market rate* is proxied by the 3-month interbank rate. *10-year bond yield* is a proxy for long-term market interest rate. *CPI* measures the rate of inflation. *GDP* is the cyclical component of real GDP. *credit-to-GDP* is the cyclical component of the credit-to-GDP ratio. *Credit* is the cyclical component of credit to the private non-financial sector. *Property prices* is the cyclical component of residential property prices. All the cyclical components of the aforementioned variables are derived using the Hamilton (2017) filter. ***, ** and * denote $p < 0.01$, $p < 0.05$ and $p < 0.1$ respectively.

In the final set of regression results, the study tests the heterogeneity of the findings by separating banks from EMEs from those in advanced economies. These regression results are presented in Table 4.6. The environment in which banks in EMEs and advanced economies operate can differ substantially. Further, while the profitability of banks in Europe and North America have been heavily researched, far less is known about banks' profitability in emerging economies. Therefore, it is worth identifying whether this relationship between liquidity and profitability holds regardless of the general economic condition under which the bank operates or whether it is being primarily driven by either group. By and large, the results are consistent with the main findings of the study. That is, irrespective of the country's economic development status, the response of bank profitability to liquidity is the same. Further, the impact of the cycles are largely in line with the main findings. The financial cycle appears more important in explaining variations in bank profits.

Table 4.6: Test for heterogeneity of results

Dependent variable (ROA)	Advanced Economies			Emerming Economies		
	I	II	III	IV	V	VI
$ROA_{i,j,t-1}$	0.401***	0.478***	0.481***	0.622***	0.554***	0.563***
	(0.047)	(0.049)	(0.053)	(0.105)	(0.106)	(0.099)
$Liquidity_{i,j,t-1}$	0.042**	0.052***	0.033***	0.044	0.054*	0.058
	(0.018)	(0.015)	(0.013)	(0.033)	(0.028)	(0.042)
$Liquidity^2_{i,j,t-1}$	-0.001***	-0.001***	-0.000***	-0.001*	-0.001**	-0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
$Leverage_{i,j,t-1}$	-0.004	-0.006***	-0.006***	0.070*	0.052	0.072
	(0.003)	(0.002)	(0.002)	(0.041)	(0.042)	(0.058)
$Risk$	-0.017***	-0.020***	-0.020***	-0.012	-0.005	-0.013
	(0.006)	(0.005)	(0.005)	(0.015)	(0.014)	(0.016)
$Size$	-0.005	-0.004	-0.003	0.045	0.045	0.047
	(0.008)	(0.007)	(0.007)	(0.067)	(0.068)	(0.085)
$Capital\ ratio$	0.014*	0.007***	0.007**	0.096**	0.087	0.094
	(0.008)	(0.003)	(0.003)	(0.044)	(0.054)	(0.061)
$Short-term\ market\ rate$	0.054*	0.029	0.007	-0.153***	-0.146***	-0.232***
	(0.030)	(0.027)	(0.028)	(0.045)	(0.044)	(0.056)
$10-year\ bond\ yield$	0.009	0.024	0.026	0.306***	0.274***	0.397***
	(0.018)	(0.019)	(0.017)	(0.062)	(0.048)	(0.069)
CPI	-3.002*	-1.643	-2.573**	-6.974**	-6.406*	-8.933**
	(1.784)	(1.580)	(1.245)	(3.465)	(3.794)	(3.619)
GDP	0.222	0.971**	0.542	0.764	0.357	-1.215
	(0.685)	(0.428)	(0.336)	(1.219)	(0.925)	(1.195)
$credit-to-GDP$	1.087***			-0.933		
	(0.383)			(0.756)		
$Credit$		0.545*			1.773**	
		(0.330)			(0.712)	
$Property\ prices$			1.070**			2.603*
			(0.431)			(1.447)
$Constant$	-0.209	-0.350	-0.101	-3.869*	-3.670*	-4.227*
	(0.341)	(0.238)	(0.210)	(2.032)	(2.058)	(2.243)
No. of banks	628	628	628	132	132	132
Observations	4,115	4,115	4,115	600	600	600
No. of instruments	78	80	83	80	80	76
AB test for AR(2)	0.32	0.23	0.21	0.17	0.18	0.21
Hansen J test	0.10	0.14	0.09	0.10	0.10	0.08

This table analyzes the impact of banks' liquid asset holdings on profitability using the system GMM estimator of Arellano-Bover. Robust standard errors are reported in parantheses. *Liquidity* is the ratio of liquid assets to total assets. *Leverage* is the ratio of assets to total shareholders' equity. *Risk* is the ratio of non-performing loans to total loans. *Size* is the log of total assets. *Capital ratio* is the ratio of regulatory capital to risk-weighted assets. *Short-term market rate* is proxied by the 3-month interbank rate. *10-year bond yield* is a proxy for long-term market interest rate. *CPI* measures the rate of inflation. *GDP* is the cyclical component of real GDP. *credit-to-GDP* is the cyclical component of the credit-to-GDP ratio. *Credit* is the cyclical component of credit to the private non-financial sector. *Property prices* is the cyclical component of residential property prices. All the cyclical components of the aforementioned variables are derived using the Hamilton (2017) filter. ***, ** and * denote $p < 0.01$, $p < 0.05$ and $p < 0.1$ respectively.

4.7 Conclusion

This essay examines the relationship between liquid asset holdings and bank profitability for 843 banks from 33 advanced and emerging market economies over the period 2005–2017. To the best of my knowledge, only one paper within the empirical literature focuses on this specific relationship. Further, the essay also presents empirical evidence regarding the cyclical behaviour of bank profits. Similarly, there exist very few papers that investigate the possible role of the financial cycle in explaining variations in bank profits. In this regard, the empirical results presented in this essay contribute to two areas of the literature that are largely unexplored.

The study uses a dynamic model specification that allows for profit persistence. The first key set of results suggest that a non-linear relationship exists between liquid asset holdings and profitability. That is, profitability is improved for banks that hold some liquid assets, however, there exist a point beyond which holding more liquid assets diminishes a banks' profitability. In theory, this finding is in line with the notion that funding markets will reward banks for holding liquid assets as they are less susceptible to liquidity risk. However, the benefit gained from this reward will eventually be redressed due to the opportunity cost of holding these comparatively low-yielding assets.

The other key result coming out of this study is that measures of the financial cycle appear to be more crucial for bank profits than the business cycle. Using three highly recommended proxies of the financial cycle from the literature, the study establishes a strong positive association with profitability, suggesting that developments in credit may be more important than output growth in explaining variations in bank profits.

In addition to the financial cycle, long-term interest rates also demonstrate a positive impact on the profitability of banks. Higher levels of long-term rates tend to increase profitability by increasing net interest margins. The impact of short-term rates is less clear. Instances where it appears significant suggests that it may raise funding costs which in turn reduces bank profits.

Important policy implications emerge from the empirical results of this study. First, as policymakers try to develop a global framework for promoting stronger liquidity buffers at financial institutions, they should also consider the trade-off between achieving resilience to liquidity shocks and the cost to banks for holding these low-yielding liquid assets. While the financial system as a whole might benefit from banks being less susceptible to liquidity risks by maintaining higher liquidity buffers, holding too many liquid assets comes with the cost of reducing the profitability of these banks. In fact, this might have a spiralling effect on the real economy as with less profits, banks may become less able to supply credit to the rest of the economy. Therefore, it is important that regulators and policymakers find the right balance between addressing liquidity risk and maintaining bank profitability.

Second, countercyclical policies aimed at smoothing credit cycles will have far greater implications on bank profitability than those geared toward smoothing the business cycle. If implemented effectively, such policies could reduce the likelihood of a significant decline of profits during a crisis. Finally, if interest rates have a systematic effect on bank profitability, and if in the short run profitability is a major determinant of bank capital, it follows that monetary policy may have implications for financial system resilience.

Chapter 5

Conclusion

5.1 Summary of Findings

This thesis uses advanced micro-econometric techniques to explore and address issues that have far reaching implications not only for the banking system, but for the economy as a whole. Following the recent financial crisis, bank capital requirements have become one of the main instruments of banking regulation, providing a cushion during downturns and serving as a preventative mechanism for risk taking. Against this background, the first essay of this thesis answers the following questions:

- Are banks' capital buffers pro-cyclical?
- Do financial variables exacerbate the cyclical behaviour of capital buffers?
- Is there heterogeneity among banks in holding capital buffers?

To answer these questions, the study applies the Arellano-Bond GMM estimator to control for various characteristics of the panel, in order to examine the cyclical behaviour of banks' capital buffers. The study relies on the widely used business cycle measure (GDP), and also introduces a novel approach in the form of a finance-augmented cycle to capture this cyclicality.

The results emanating from the study suggest that a negative relationship exists between banks' capital buffers and the business cycle. This means, during stress periods banks increase their capital buffer, whilst in booms they tend to reduce it. More importantly, the study finds that these capital buffers are even more pro-cyclical when using a finance-augmented output gap. Further, it finds that this negative relationship is exclusively related to large banks, consistent with the "too big to fail" hypothesis.

The findings from the first essay add to the strand of literature which focuses on the cyclicality of banks' capital ratios (for e.g. Repullo and Suarez (2013), Estrella (2004), Coffinet et al. (2012), and Shim (2013)). However, it builds on these papers by including financial sector developments in the business cycle and getting more reliable estimates of said cycle.

The second essay exploits the introduction of an allowance for corporate equity in Italy which provides a unique way isolate and examine the impact of a tax shield on bank capital structure. In particular, this essay attempts to answer the following questions:

- Does the introduction of a tax shield for equity increase bank equity ratios?
- Does the allowance for corporate equity cause banks to reduce their level of riskiness?

Using a difference-in-differences method this essay makes a comparison between the change in capital structure for Italian banks with a closely related group of European banks that did not experience a similar change in their corporate tax system. The results suggest that, following the introduction of the ACE, the equity ratio of the average Italian bank increases by approximately 8.5%. Since the ACE is a tax shield for equity, equity funding becomes more attractive and banks increase their equity ratio. The results provide further evidence that the increase in equity ratios is being driven by an increase in bank equity rather than a reduction in any loan activity by banks. Additionally, the study finds that this tax relief for equity reduces risk taking for weakly capitalized banks.

The findings from the essay contribute to ongoing discussions surounding bank capital regulation and bank capital structure decisions. It importantly adds to the developing body of literature surrounding the introduction of tax shields for equity to reduce the relative tax advantage of debt (see for e.g. Schepens (2016) and Célérier et al. (2017)). To the best of my knowledge, a similar study has not been done for financial institutions in Italy. Furthermore, the nature of Italy's banking system and the timing of the tax reform make the findings of this essay even more relevant, especially for regulators.

The third essay explores the relationship between liquid asset holdings and bank profitability for banks in emerging market economies and advanced economies. In addition, it also attempts to some shed some light on the cyclical behaviour of profits by testing whether the financial or the business cycle is a better predictor. As such, the essay sets out to address the following questions:

- Is the relationship between liquid asset holdings and bank profitability non-linear?
- What is the role of the business cycle in explaining bank profits?
- Does the financial cycle predict bank profitability better than the business cycle?
- Is the reaction by banks homogeneous across countries with different development status?

Considering the persistence of the profitability indicator much discussed in the literature, the essay utilises the system GMM estimator to provide empirical answers to these questions. The first key resulting emanating from the empirical analysis in this chapter is that the relationship between banks' liquid asset holdings and profitability is non-linear. Specifically, it shows that, in the first instant, banks are rewarded profitably for holding some liquid assets, however, profits eventually start to decrease as banks continue to hold these generally low yielding assets.

The other major result coming from this empirical experiment is that measures of the financial cycle appear to be more important for bank profitability than the business cycle. This finding is consistent for all three of the proxies used to capture the financial cycle. Finally, the study also shows that long-term interest rates consistently predict bank profitability better than short-term rates. Specifically, higher levels of long-term interest rates tend to increase profitability by increasing net interest margins, whilst the impact of short-term rates is mainly insignificant.

This essay makes an important contribution to the literature by exploring a determinant of bank profitability that has been largely ignored. It also adds to the strand of literature that analyses the cyclical behaviour of profitability, and explores a phenomenon that has also been largely ignored.

5.1.1 Policy Implications

Several important policy implications can be drawn from this thesis. From the first essay, and consistent with the literature, it is clear that on average banks capital buffers exhibit a pro-cyclical behaviour. This reinforces the need to effectively implement the Basel Accord proposed countercyclical buffer tools. Regulators might need to adopt more flexible instruments to mitigate credit risk in banks globally. This recommendation is motivated by the fact that even with the prudential framework set out in the new Basel accords (Basel III), the pro-cyclical behaviour of banks' capital buffers will still persist. The finding of a greater degree of pro-cyclicality of banks' capital ratios would suggest that the approach to setting the countercyclical capital buffer rate for banks might need to be more rigid. That is, it might be necessary to set the CCB rate above the current minimum requirement for individual banks and the banking sector.

Another implication related to the use of countercyclical policy tools is their flexibility. The analysis in the first essay shows that it is not always safe to assume that regulatory or supervisory capital standards automatically constrain banks. Market power, for example, may induce banks to hold capital in excess of the minimum required, thereby reducing the power of capital requirements as instruments of financial stability. Given the fact that big and small banks behave differently and banks with different specialisation also treat capital buffer differently, these variations should be taken into consideration when employing efforts to revamp the regulatory landscape. This could be achieved by creating more flexible and cycle-sensitive capital regulations.

The second essay also provides important implications in terms of the proposal of regulatory tools to address the capital structure decision of banks. The key policy implication coming out of this chapter is the recognition that an ACE system that eliminates or significantly reduces the tax-induced distortions in banks, might be worth considering as a macroprudential policy tool that targets capital standard.

This sort of instrument becomes even more important due to the shortcomings of previous policy attempts to address this bias towards debt. For instance, many countries have implemented measures that place a ceiling on interest deductibility, often referred to as thin capitalisation rules. Buettner et al. (2008) document that the share of OECD countries applying these rules grew from less than 50 per cent to more than 75 per cent between 1996 and 2004. Weichenrieder and Klautke (2008) report that these rules have reduced debt ratios. However, Buettner et al. (2008) argue that they also seem to reduce investment. Further, De Mooij (2012) suggest that these rules are only imperfect solutions to the debt bias problem and come along with other costs. They argue that these rules are not properly designed so firms often find loopholes by exploiting hybrid instruments cross-order differences in the definitions of equity and debt.

The third essay provides evidence of a non-linear relationship between liquidity holdings and bank profitability. Thus, regulatory authorities such as the BCBS may need to take this into consideration when setting the liquidity requirements for banks. As these policymakers attempt to develop a framework for promoting stronger liquidity buffers at financial institutions, they should also consider the opportunity cost to banks for holding a considerably high amount of these low yielding assets. Though the global financial system benefits from banks becoming less susceptible to liquidity shocks, holding too much liquid assets comes at a cost of reduced profitability. In fact, this reduced profitability might even affect banks ability to provide credit, hence affecting the economy as whole. It is therefore important that regulators try to find some optimum liquidity buffer or other means of balancing liquidity risk and profitability.

Another policy implication coming out of the third essay surrounds countercyclical regulation. With the essay documenting evidence of a significant relationship between the financial cycle and profitability, and no evidence of the business cycle significantly predicting profitability, regulators may need to target the credit cycle with countercyclical policies. Based on the evidence in this essay, countercyclical policies aimed at smoothing credit cycles will have far greater implications on bank profitability than those geared toward smoothing the business cycle. If such policies are effectively implemented, they could reduce the likelihood of a significant loss in profits during a crisis.

Finally, if interest rates have a systemic effect on bank profitability, and in the short-run profitability is a major determinant of bank capital, it therefore follows that monetary policy also has important implications for the resilience of the financial system.

5.1.2 Limitations and Scopes for Future Work

Notwithstanding the important implications coming out of the analysis in this thesis, there were a number of limitations and the thesis also serves as a stepping stone for additional work.

The analysis in the first essay indicates that our assessment of the business cycle and the pro-cyclicality of capital buffers changes when financial information is added to the filter representing the output gap. Apart from the fact that the unavailability of sufficient financial cycle data limits this particular part of the study to only the G7 countries, there are other important caveats to this finding. From a measurement perspective, the results would be more robust and persuasive if both measures of the cycles were multivariate. As it stands, it would not be completely accurate to suggest that it is financial factors in particular that are truly important.

Therefore, an extension to this work could be to add other standard variables (for e.g. unemployment) to the business cycle filter to allow for a more fair comparison.

Continuing with the findings in the first essay, the study concludes that capital buffers are more pro-cyclical based on the magnitude and significance of the coefficient on the output gap. Whilst the significance provides a good indication, the magnitude of the coefficient depends on how large the estimated business cycles swing are. This on its own is not sufficiently strong to confidently make a claim of more or less cyclicality. Future work could use other evaluation metrics such as a “horse-race”, that is, to include both gaps in the model at the same time and see which comes out ahead. A more sophisticated approach could be to estimate a phase shift between the capital buffer and the outputs gaps. However, this approach would be a lot more technical and require a bit of time.

The second essay also provides scopes for further work and extensions. An ideal experiment would have been to examine the equity ratios for a few more years beyond the treatment period of 2012-2013 to see whether the trend continues. Due to the unanticipated removal of the database used in this study, this was not done. However, this could be carried out using data from a new database, for example the SNL database maintained by S&P Global.

As the third essay is one of the first to empirically investigate the relationship between liquidity assets and profitability, it has opened up avenues for future work. Having identified that a non-linear relationship exists between liquid assets and profitability, it is my intention to extend this work by attempting to find optimal liquid asset holdings. That is, I will attempt to find the turning point of liquid assets. Another possible extension could be to carry out the study focusing on countries with and without pre-existing bank liquidity requirements. A further suggestion, which is highlighted in Bordeleau and Graham (2010), would be to explicitly model the determinants of bank liquid assets or even establish a general equilibrium model including bank profitability and liquidity.

In terms of the relationship between bank profitability and the cycles, an approach akin to what is used in chapter one could be adopted. That is, the study could use a multivariate approach to model both the financial and business cycles.

Overall, the analysis in this thesis addresses important developments in the financial sector that have implications for the economy as a whole. Various factors including data and time have limited the extent to which this thesis could address these developments. Nonetheless, this thesis marks a first attempt to address these issues and serves as a stepping stone for future empirical and theoretical work.

Appendix

Appendix to Chapter 2

Table A1: Countries and number of banks

Country	Total no. of banks	Commercial bank	Cooperative banks	Savings banks
AUSTRALIA	10	9	1	
AUSTRIA	16	9	5	2
BELGIUM	9	6	1	2
BRAZIL	25	25		
CANADA	6	5	1	
CZECH REPUBLIC	5	5		
DENMARK	16	12		4
ESTONIA	5	5		
FINLAND	5	4	1	
FRANCE	16	13	3	
GERMANY	8	7	1	
GREECE	7	7		
HUNGARY	6	6		
INDIA	12	12		
INDONESIA	14	14		
ISRAEL	10	10		
ITALY	38	17	16	5
JAPAN	116	109	7	
LATVIA	8	8		
LUXEMBOURG	5	5		
MEXICO	15	13	1	1
NETHERLANDS	13	12	1	
NEW ZEALAND	5	5		
NORWAY	26	4		22
POLAND	12	10	1	1
PORTUGAL	7	6		1
SLOVAKIA	5	4		1
SLOVENIA	7	7		
SPAIN	17	9	2	6
SWITZERLAND	5	4	1	
TURKEY	18	18		
U.K	15	15		
U.S.A	71	60	3	8

Table A2: Estimation using G7 countries

	(1) C-F filter
$Buff_{i,j,t-1}$	0.681***
	(0.073)
ROE	4.384***
	(1.139)
$Risk$	0.262**
	(0.104)
$Size$	-0.121
	(0.517)
$\Delta Loan$	-0.036***
	(0.007)
$Business\ cycle$	-4.456***
	(1.527)
$\alpha(1)$	0.00
$\alpha(2)$	0.41
Hansen J	0.85
Observations	2,540
No. of instruments	132
No. of banks	281

Notes: This table provides a specification uisng the Christiano-Fitzgerald filter as the cyclical indicator. The estimation is once again based on the Arellano and Bond (1991) difference GMM estimator. Robust standard errors are reported in parentheses, $\alpha(1)$ and $\alpha(2)$ are first and second order residual autocorrelation tests. The null hypothesis of the AR(2) test is that errors in the first-difference regression exhibit no second-order serial correlation. The null hypothesis of the Hansen test is that the instruments are valid. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table A3: Estimation using G7 countries (Standardised cycle coefficients)

	(1) HP	(2) Hamilton	(3) UC Model	(4) Multivariate UC Model	(5) Multivariate UC Model
$Buff_{i,j,t-1}$	0.636***	0.644***	0.501***	0.692***	0.630***
	(0.060)	(0.062)	(0.079)	(0.080)	(0.079)
ROE	4.371***	4.454***	4.875***	5.114***	4.456***
	(1.089)	(1.059)	(1.230)	(1.171)	(1.164)
$Risk$	0.219**	0.223**	0.242***	0.264**	0.207***
	(0.097)	(0.097)	(0.084)	(0.107)	(0.067)
$Size$	0.483	0.348	0.436	0.250	0.540
	(0.375)	(0.356)	(0.434)	(0.485)	(0.570)
$\Delta Loan$	-0.033***	-0.033***	-0.034***	-0.031***	-0.042***
	(0.006)	(0.006)	(0.009)	(0.006)	(0.010)
$Business\ cycle$	-0.102***	-0.117***	-0.050**		
	(0.030)	(0.032)	(0.022)		
FAC_a				-0.216***	
				(0.051)	
FAC_b					-0.053
					(0.071)
$\alpha(1)$	0.00	0.00	0.00	0.00	0.00
$\alpha(2)$	0.65	0.56	0.36	0.28	0.86
Hansen J	0.94	0.98	0.12	0.92	0.34
Observations	2,540	2,540	2,540	2,324	2,324
No. of instruments	132	132	132	132	118
No. of banks	281	281	281	281	281

Notes: This table replicates Table 2.5 using standardised versions of all the cyclical measures. All estimations are once again based on the Arellano and Bond (1991) difference GMM estimator. Robust standard errors are reported in parentheses, $\alpha(1)$ and $\alpha(2)$ are first and second order residual autocorrelation tests. The null hypothesis of the AR(2) test is that errors in the first-difference regression exhibit no second-order serial correlation. The null hypothesis of the Hansen test is that the instruments are valid. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table A4: Marginal effects

	ey/ex	Delta-method Std. Error	Z	P>|Z|
HP	-0.0007698	0.0005189	-1.48	0.14
$Hamilton$	0.0034495	0.0016830	2.05	0.04
UCM	0.0033691	0.0025392	1.33	0.19
FAC_a	-0.0054781	0.0030563	-1.79	0.08
FAC_b	-0.0019543	0.0011422	-1.71	0.09

Notes: This table presents the marginal effects of each cyclical component in specifications 1 through 5 in Table 2.5.

Table A5: Correlation matrix

	HP	Hamilton	UCM	FAC_a	FAC_b
HP	1				
Hamilton	0.57	1			
UCM	0.45	0.61	1		
FAC_a	0.49	0.65	0.55	1	
FAC_b	0.12	0.09	0.06	-0.50	1

Notes: This table presents the cross-correlation matrix of the cyclical variables used throughout chapter one.

Appendix to Chapter 3

Table A6: Country list

Country	No. of banks	Country	No. of banks
Austria	42	Latvia	16
Bulgaria	13	Lithuania	7
Croatia	8	Luxembourg	18
Cyprus	13	Malta	6
Czech Republic	11	Netherlands	34
Denmark	28	Poland	22
Estonia	8	Portugal	22
Finland	18	Romania	9
France	112	Slovakia	7
Germany	55	Slovenia	9
Greece	8	Spain	46
Hungary	13	Sweden	22
Ireland	11	United Kingdom	85
Italy	65		

This table gives information on the number of banks in each country.

Table A7: Variable definitions

Variable	Description	Source
Bank-specific variables		
Equity ratio	Total equity over total assets	Bankscope
Return on assets	Profits over total assets	Bankscope
Risk	Raito of non-performing loans over total loans	Bankscope
Diversification	Non-interest income over gross revenue	Bankscope
Loan ratio	Total loans over total assets	Bankscope
Total assets	Total assets (in millions of US dollars)	Bankscope
Loans	Total loans (in millions of US dollars)	Bankscope
Equity	Total equity	Bankscope
Z-score	Ratio of equity plus ROA over std. dev.(ROA)	Bankscope
Retained earnings	Retained income over post-tax profit	Bankscope
Country-specific variables		
GDP per capita growth	Growth in gross domestic product per capita	WDI
CPI rate	Change in consumer price index	WDI

This table provides definitions of the variables used throughout the analysis in Chapter in 3. The table also documents the data source for the variables.

Table A8: Heterogeneity in the treatment effect and bank risk behaviour

	Low-capitl banks	High-capital banks	Low-capital banks	High-capital banks
	ln(ETA)	ln(ETA)	ln(Risk)	ln(Risk)
DiD	0.115***	0.207***	-0.248**	0.941
	(0.040)	(0.019)	(0.102)	(0.598)
Post	-0.047**	-0.204***	0.339***	-0.180
	(0.021)	(0.018)	(0.036)	(0.250)
Constant	-8.024	-1.747	91.797***	14.396
	(5.390)	(2.564)	(10.705)	(29.025)
Observations	883	165	842	109
R-squared	0.439	0.911	0.467	0.204
Bank FE	Yes	Yes	Yes	Yes
Cluster level	Bank	Bank	Bank	Bank

This table illustrates the difference in the impact of the ACE on high and low capitalised banks. The sample period is again 2008 to 2013. The Post dummy equals one in 2012 to 2013, the Treated dummy takes the value of one for the Italian banks. The first two columns show the the impact of the ACE on (ex-ante) high and low capitalised banks. Here high capitalised banks are those whose equity ratio fall in the highest decile of the size distribution within each country. Low capitalised banks are those that fall in the bottom 30 percentile of the size distribution within each country. The sample for the highly capitalised banks now comprises of 8 treated banks and 56 untreated banks. For the low capitalised sample, there are 16 treated banks and 177 untreated banks. In the third and fourth column, I examine the ex ante risk-taking behaviour of these high and low capitalised banks. I use the ratio of non-performing loans to total loans as the left hand side variable. All regressions include bank fixed effects, standard errors are clustered at the level. ***, **, and * denote the $p < 0.01$, $p < 0.05$ and $p < 0.1$, respectively.

Table A9: Placebo tests

Panel A	Austria	Bulgaria	Croatia	Cyprus	Czech Republic	Denmark	Estonia	Finland
	ln(ETA)	ln(ETA)	ln(ETA)	ln(ETA)	ln(ETA)	ln(ETA)	ln(ETA)	ln(ETA)
DiD	0.019	0.027	0.037	-0.139	0.096	-0.023	-0.165	0.023
	(0.032)	(0.034)	(0.041)	(0.142)	(0.105)	(0.035)	(0.101)	(0.054)
Post	-0.019	-0.019	-0.019	-0.016	-0.020*	-0.017	-0.016	-0.018
	(0.012)	(0.011)	(0.012)	(0.011)	(0.011)	(0.012)	(0.011)	(0.011)
Constant	-2.372	-2.416	-2.462	-2.070	-2.428	-2.363	-2.994	-2.443
	(2.255)	(2.252)	(2.258)	(2.349)	(2.251)	(2.266)	(2.256)	(2.255)
Observations	2,113	2,113	2,113	2,113	2,113	2,113	2,113	2,113
R-squared	0.450	0.450	0.450	0.451	0.451	0.450	0.452	0.450
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster level	Bank	Bank	Bank	Bank	Bank	Bank	Bank	Bank

Panel B	France	Germany	Greece	Hungary	Ireland	Latvia	Lithuania	Luxembourg
	ln(ETA)	ln(ETA)	ln(ETA)	ln(ETA)	ln(ETA)	ln(ETA)	ln(ETA)	ln(ETA)
DiD	0.018	0.002	-0.542***	-0.010	0.055	-0.102*	-0.094	0.070
	(0.020)	(0.028)	(0.208)	(0.050)	(0.047)	(0.062)	(0.120)	(0.051)
Post	-0.021	-0.018	-0.006	-0.018	0.029	-0.015	-0.017	-0.019*
	(0.013)	(0.012)	(0.010)	(0.012)	(0.030)	(0.011)	(0.011)	(0.011)
Constant	-2.406	-2.404	2.081	-2.413	3.340	-2.751	-2.700	-2.509
	(2.249)	(2.339)	(1.774)	(2.264)	(3.888)	(2.284)	(2.284)	(2.255)
Observations	2,113	2,113	2,113	2,113	1,367	2,113	2,113	2,113
R-squared	0.45	0.45	0.46	0.45	0.412	0.451	0.451	0.450
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster level	Bank	Bank	Bank	Bank	Bank	Bank	Bank	Bank

Panel C	Malta	Netherlands	Poland	Portugal	Romania	Slovakia	Slovenia	Sweden	UK
	ln(ETA)	ln(ETA)	ln(ETA)	ln(ETA)	ln(ETA)	ln(ETA)	ln(ETA)	ln(ETA)	ln(ETA)
DiD	-0.009	0.022	0.102*	0.067	-0.102	0.060	0.118	-0.059	-0.020
	(0.076)	(0.041)	(0.054)	(0.061)	(0.065)	(0.055)	(0.099)	(0.055)	(0.030)
Post	-0.018	-0.019	-0.021*	0.015	-0.016	0.028	-0.014	-0.016	-0.015
	(0.011)	(0.012)	(0.011)	(0.011)	(0.011)	(0.030)	(0.013)	(0.011)	(0.012)
Constant	-2.429	-2.456	-1.593	-2.777	-2.313	3.509	-0.823	-2.455	-2.370
	(2.252)	(2.257)	(2.331)	(2.271)	(2.269)	(3.884)	(3.715)	(2.255)	(2.278)
Observations	2,113	2,113	2,113	1,756	2,113	1,367	2,455	2,113	2,113
R-squared	0.450	0.450	0.451	0.421	0.451	0.412	0.465	0.450	0.45
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster level	Bank	Bank	Bank	Bank	Bank	Bank	Bank	Bank	Bank

This table provides an extension to the robustness check done in Table 3.6, with regards to the placebo test. Banks from each of the remaining countries in the control group are used as fake treated banks. For each of these specification, Italy is removed from the sample. ***, **, and * denote $p < 0.01$, $p < 0.05$ and $p < 0.1$, respectively.

Appendix to Chapter 4

Table A10: Banks by country

Country	Status	No. of Banks
Australia	Advanced	16
Austria	Advanced	18
Belgium	Advanced	8
Canada	Advanced	13
Chile	EME	7
Colombia	EME	14
Czech Republic	EME	6
Denmark	Advanced	11
Finland	Advanced	5
France	Advanced	81
Germany	Advanced	26
Greece	Advanced	5
Hungary	EME	8
India	EME	9
Ireland	Advanced	11
Israel	EME	6
Italy	Advanced	38
Japan	Advanced	125
Luxembourg	Advanced	8
Mexico	EME	44
Netherlands	Advanced	11
New Zealand	Advanced	7
Norway	Advanced	25
Poland	EME	12
Portugal	Advanced	6
Russia	EME	25
South Africa	EME	6
South Korea	EME	21
Spain	Advanced	20
Sweden	Advanced	11
Switzerland	Advanced	14
USA	Advanced	189
United Kingdom	Advanced	37

Table A11: Cross-correlation matrix of independent variables

	Liquidity	Leverage	Capital	Size	NPL/loans	Short-term rate	Long-term rate	CPI	GDP	Credit-to-GDP	Property prices	Private credit
Liquidity	1											
Leverage	0	1										
Capital ratio	0.14	-0.01	1									
Log of assets	0.22	0.03	-0.20	1								
NPL/loans	-0.04	-0.01	-0.09	0.12	1							
Short-term rate	-0.01	0.01	0.01	-0.08	0.12	1						
Long-term rate	-0.05	0.00	0.01	-0.11	0.28	0.79	1					
CPI rate	-0.03	0.01	-0.02	-0.04	0.15	0.46	0.41	1				
GDP	0.06	-0.03	0.07	-0.05	-0.14	0.04	-0.06	-0.07	1			
Credit-to-GDP	-0.02	0.03	0.01	-0.07	-0.06	0.39	0.32	0.18	0.19	1		
Property prices	-0.03	-0.02	0.04	-0.06	-0.04	-0.07	-0.10	-0.17	0.42	0.02	1	
Private credit	-0.02	0.01	-0.05	0.02	0.01	0.33	0.21	0.07	0.11	0.04	0.18	1

Figure A1: Banks' liquid assets holdings over time

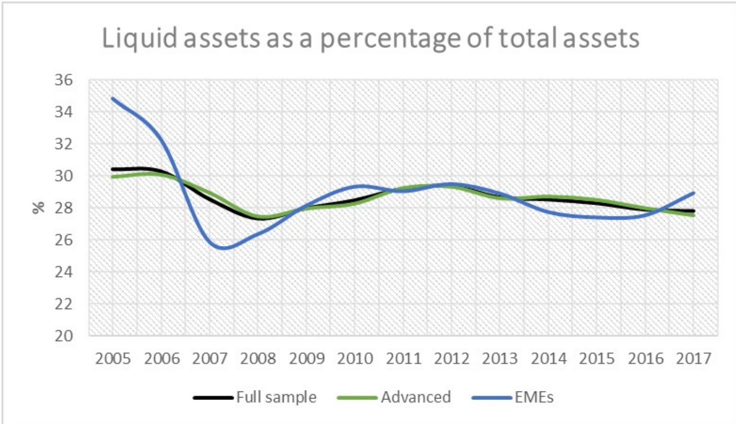


Figure A2: Bank profitability (ROE) and the macroeconomic cycles

Figure A3: Bank profitability (pre-tax profit) and the macroeconomic cycles

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